Manual of Surgery Vol. I.

Frederick Treves F.R.C.S.

MANUAL OF SURGERY.

In Treatises by Various Authors.

IN THREE VOLUMES.

EDITED BY

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Volume I.

GENERAL SURGICAL AFFECTIONS—THE BLOOD-VESSELS
—THE NERVES—THE SKIN.

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omitted, with the exception of such as concern what may be termed special operations, viz. tracheotomy, gastrostomy, nephrectomy, ovariotomy, and the like. In similar manner, pathology is discussed only in so far as it directly affects the clinical phases and the intelligible treatment of surgical disease.

I cannot too warmly express my thanks to the many eminent surgeons who have kindly co-operated in this work, or too fully recognise that to them must belong whatever merit the Manual may possess.

THE EDITOR.

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Manual of Surgery.

Volume I.

I. THE PROCESS OF REPAIR.

Prof. John Chiene.

As the result of an injury to any part of the body, certain changes occur in the injured part. The injury may be so severe as to cause immediate death; or it may render recovery impossible, and death, local or general, ultimately takes place; or the patient may be able to withstand the effects of the injury, and recovery, more or less complete, takes place, certain local changes occurring at the seat of injury. These local changes constitute what is known in surgery as the "*process of repair.*"

During health certain processes are constantly going on in the tissues. In them there is constant change and interchange of material. The blood circulating in the tissues conveys nutriment to them, while directly through the walls of the capillaries, or indirectly through the lymphatics, it receives various effete products, or unused material, from them. In health these two processes of addition and withdrawal balance each other; they are performed imperceptibly, and the tissue maintains its functional activity. After an injury, however, the balance in the injured part is lost. The blood still performs its functions, but there is now an increased afflux of blood to the injured part, and an increased deposit in its tissues. This increase is often associated with a diminished withdrawal of effete products, which accumulate in the injured part and interfere with its functional activity.

An injury is the result of the application of an irritant. The irritant may be applied directly to the part, or indirectly. In the latter case it acts through the nervous system. For example, abscess of one of the cervical glands may result directly from a twist or strain of the neck, or indirectly from the irritation of a carious tooth, one of the commonest causes of abscess in that region. Or, again, a swollen testicle may result directly from a kick, or indirectly from gonorrhœa.

If the action of the irritant be slight, it may have no other effect than merely to stimulate the tissues to increased activity; if more severe, the result may be a depression of the functional activity of the part; if still more severe, or sufficiently protracted, the irritant may give rise to a local death. These different effects vary in different people, for the result of the irritant depends not merely on its severity, but on the strength or power of resistance of the tissues to which it is applied, and this varies with the state of health of the individual at the time of the injury. And thus we find bed-sores forming in patients suffering from some wasting disease. Here the irritant is the constant pressure of the body. In a case of fracture of the thigh they are not nearly so likely to form, because in such an accident the general vitality of the patient is not necessarily lowered. A mustard poultice in a healthy person gives rise to a temporary congestion. In a weakly child it may cause superficial destruction of the skin.

Phenomena observed in an injured part.—Having stated generally the effects of the application of an irritant, let us now consider more particularly the phenomena to be observed in an injured part, resulting in recovery or in local death, in order that the changes included in the process of repair may be more clearly understood. In this connection *three* elements require to be considered : the blood-vessels, the blood, and the tissues surrounding the blood-vessels.

The blood-vessels in question are the arterioles, capillaries, and small veins; and the most important facts about them in this connection are, that their walls are thin and membranous, the capillaries being formed merely of an elastic endothelium, and that free interchange is permitted through them between the blood and the surrounding tissues.

If a transparent membrane, such as the web of a frog's foot, be examined, it will be seen that in any particular vessel in health there are two streams, a lateral slower one, and a central faster one. In the former the colourless corpuscles are seen moving slowly along, and adhering at times to the sides of the vessel. If an irritant now be applied, the first change that may be observed is a contraction of the vessel, but this is very momentary, and of little importance. The first important change is that of dilatation of the walls of the vessel, and this affects capillaries, arterioles, and small veins. Along with the dilatation the rate of flow in the capillaries is increased at first, owing to their not dilating to the same extent as the arterioles ; but this increased rate of flow is of short duration, and, after a certain amount of oscillation, the current becomes slower, and finally ceases. In other words, "*stasis*" has occurred.

Along with the slowing of the current a change takes place in the lateral stream. It contains more colourless corpuscles. These attach themselves to the walls of the vessel, pass through them, and migrate into the surrounding tissues. To this emigration of the white corpuscles the term "*diapedesis*" is applied.

Still another change takes place, *excessive exudation.* Normally there is a constant outflow of the blood plasma, or fluid portion of the blood, into the surrounding tissues. In an injured part this occurs to excess, and it is this that gives rise to the œdematous swelling of an injured part.

Causes of the dilatation and of the stasis.—It has been already stated that an irritant may act directly or indirectly. The irritant here probably acts in both ways: directly on the vessel walls, depressing their vitality, and lessening their power of contraction; and indirectly through the nervous system, causing a vaso-motor paralysis, and thus producing dilatation. The main factor in the causation of the stasis is the viscidity of the blood, due to its contact with the depressed vessel walls.

We have arrived, therefore, at a stage of *increased deposit in the tissues*, consisting (*a*) of blood plasma or liquor sanguinis, due to the increased intravascular pressure, assisted by the thinning of the walls of the vessels; and (*b*) of colourless blood corpuscles. Certain changes may occur in this deposit. Normally, the blood consists of corpuscles in a fluid, the blood plasma. If blood be poured out from the body it rapidly passes through a series of changes. It first becomes viscid, then it clots, and lastly the clot contracts, squeezing out from itself as it does so a fluid termed serum. The clot consists of fibrin, entangling in its meshes blood corpuscles. Fibrin normally exists in a fluid state in the blood, and is then termed fibrinogen. Coagulation is caused by the action on this fibrinogen of a ferment, the "fibrin ferment," which under certain circumstances is evolved from the white, but possibly also from the coloured corpuscles. The circumstances under which the fibrin ferment is evolved, are contact with decaying or sufficiently depressed or dead matter.

In an injured part we have liquor sanguinis and white blood corpuscles together in the presence of depressed tissue; in other words, if the irritant have caused sufficient depression of the tissues, we have present all the elements necessary for the formation of a colourless clot. Such is the real nature of the so-called "coagulable lymph."

So far, then, we have seen that (1) there is increased afflux of blood to the injured part. (2) There is an increased deposit in the part, which may undergo certain changes. There may be (3) increased production in the injured part.

The white blood corpuscles or leucocytes that have migrated multiply, and the cellular elements of the tissues themselves, especially in the less vascular parts of the body, undergo rapid proliferation. This is due to the over-feeding of the tissue. Normally the tissues grow and are maintained by the proliferation of their cell elements. In an injured part this occurs to an abnormal degree, *not* because of the increased vitality of the tissues, for their vitality is depressed, but because the normal balance of nutrition is lost. There is an increase in the amount produced, but the character of the products is inferior, and thus instead of proliferating to produce normal tissue, the cell elements of the tissues proper, and the leucocytes that have migrated, may multiply into various aborted products, the chief of which is pus.

Process of recovery.—If the irritant be withdrawn, recovery more or less complete may occur at different stages in the above series of events. If in the stage of active congestion of the vessels, or in that of stasis, the irritant be removed, the vessels begin to regain their tone, and recovery sets in, beginning at the venous extremities of the capillaries, or at the small veins themselves, when the corpuscles are seen to move onwards and resume their normal course. If the process has gone on to effusion of the liquor sanguinis and migration of white blood corpuscles into the surrounding tissues, these may be absorbed again by the blood-vessels and lymphatics, and the part be restored to its normal condition. *Resolution*, as it is termed, occurs. Should, however, the so-called "coagulable lymph" have formed, occupying a definite area, recovery, if it take place, must be by a new method, and certain changes occur, varying with the size of the clot, its surroundings, its situation, and its treatment.

Hitherto, for the sake of simplicity, we have considered a case where the irritation has not been so severe as to produce a rupture of any vessel; but practically, owing to the great vascularity of the tissues, rupture of some vessels, however small, almost always takes place, and hence we have hæmorrhage. The process of repair in the tissues after the formation of the colourless clot will be more readily apprehended if we first consider the process of repair in a wounded vessel, and then that in the injured tissues.

I. **Process of repair in a wounded artery.**—If the surface of a wound, in which no large artery has been divided, be examined, at first a general bleeding from the whole surface will be seen. Then after a time the capillary flow ceases, and the hæmorrhage becomes limited to certain spots, where it occurs in jets of bright red blood, that issue from some small arteries. If attention be directed to any one of these jets, it will be seen to become smaller in size, and to come with less velocity, and, passing into a trickle, finally to cease altogether. This is termed the *natural arrest of hæmorrhage.* How does it take place? In the case of the capillaries and arteries the vessel walls collapse, and the vitality of their cut ends being depressed, coagulation speedily occurs. If an artery of ordinary size be cut across, the process is somewhat more complicated. (1) The vessel contracts in virtue of the circular fibres in its middle or muscular coat. (2) It at the same time is retracted within its sheath by the longitudinal and oblique fibres of its external coat. (3) The sheath collapses, and so helps to make the opening still smaller. (4) A clot forms, beginning at the sides of the sheath and extending till the channel between the retracted cut end of the vessel and the cut end of the sheath is filled. This is the *external* clot, and it acts as a temporary means of arrest.

But the process of clotting extends farther, and passes into the lumen of the cut vessel, generally as far as the first branch. This is known as the *internal* clot. It is pyriform in shape, and acts as a sort of buttress protecting the external clot, and allowing changes to take place in it which bring about the permanent closure of the vessel. Such changes are necessary, for the clot is a rudimentary structure, and is formed, too, at a time when the blood pressure is lower than it is as soon as the bleeding is arrested. The moment this occurs the weakened circulation begins to recover, and any sudden increase in the blood pressure would easily sweep the clot away. The changes that now occur in the clot are, in essence, the same as those that occur in the repair of the tissues in an injured part, and a knowledge of them is of the greatest importance in practical surgery.

1. The internal clot becomes adherent to the sides of the vessel.

2. At its junction with the external clot a change in colour begins, and extends throughout the whole clot. It becomes of a lighter tint, due to the breaking down and absorption of the coloured corpuscles. Their function is gone; they are no longer of use, but in the way, and they are got rid of.

3. The clot becomes loaded with cells like white

blood corpuscles, due in part to proliferation of the cell elements of the surrounding tissues, especially the epithelium of the cut artery, and in part to the migration into it of white blood corpuscles.

4. The next step is the *vascularisation* of the clot, vessels shooting into it chiefly from the vasa vasorum.

5. The clot then loses its vascularity, while at the same time general contraction takes place. Fibrous tissue is formed in it, and ultimately all that remains of the original blood clot is a fibrous cord, sealing the mouth of the vessel, and tapering off into the surrounding tissues.

II. **The process of repair in other injured tissues** is practically identical in substance with that which occurs in a wounded vessel. In other words, repair in every wound takes place by means of blood clot (John Hunter). The formation of "coagulable lymph" or the colourless clot, in an injured part where there has been no rupture of the blood-vessels, has already been considered. The process of repair is the same, whether the clot be coloured or whether it be colourless. The coloured corpuscles may practically be regarded as inert, and acting rather as obstacles to the contraction and organisation of the clot than anything else.

What are the changes, then, that may take place in a clot in the tissues? They depend on its surroundings, its size, its situation, and its treatment. These factors determine whether the result shall be one of recovery, or whether disintegration and death of the part shall ensue. Our present consideration is the former alternative. The latter will be dealt with in another connection.

Given healthy tissues for surroundings, a clot occupying not too large an area, not exposed, and not irritated in any way, it will pass through the changes described in connection with the repair of a wounded vessel, and the place which it occupied will become filled with tissue resembling its surroundings.

Inflammation.—The early stages of inflammation are practically the phenomena to be observed in an injured part; and we have already seen how at several stages in the series of events described, on the withdrawal of the irritant, recovery may take place. Should, however, the irritants be so severe as to injure a portion of the tissue, even if it be very small, beyond the possibility of recovery; or if the irritation be kept up, *e.g.* by the presence of some foreign body in the tissues (it may be the clot itself, of large size, exerting pressure on its surroundings), then resolution cannot take place. The exudation of the liquor sanguinis and the migration of the colourless corpuscles go on. The tissues become more and more swollen, they soften and disintegrate. The abnormal pressure or tension acting on the terminations of the sensory nerves gives rise to pain, and acting reflexly, favours further dilatation and exudation.

Even at this stage, if the irritant be removed, if the tension be relieved, recovery may take place; otherwise the process goes on to the formation of pus, and *suppuration* occurs. (*See* Art. IV.) The pus may accumulate in the injured part, and give rise to the formation of an abscess. If it is formed on an open surface, so as to have free exit, we have a gradual casting off of the products of the disintegration of the tissues as molecular débris, another termination of inflammation named *ulceration*. Or, again, the inflammation may end more rapidly, and give rise to the death of a certain amount of tissue *en masse*. To this termination of inflammation the name of *mortification*, or *gangrene*, is applied.

Causes of inflammation.—Just as the effect of an injury depends on two factors, the irritant itself and the power of resistance of the tissues affected, so in the same way the causes of inflammation may be regarded as forming two groups, *exciting* and *predisposing.* Anything that tends to lessen the power of resistance of the tissues is a *predisposing cause.* The more important *predisposing causes* are :

1. *Constitutional peculiarities.*—These may be : (*a*) Hereditary tendencies, *e.g.* gout, syphilis, or scrofula. (*b*) Bad habits, such as intemperance in eating or drinking. (*c*) Starvation. (*d*) Over-sensitiveness ; in some such cases a mild irritant, such as a poultice, will produce a severe effect. (*e*) Altered or weakened nerve power ; when the nervous supply of a part is weakened or cut off, slight irritation will lead to inflammation, as *e.g.* when bed-sores form in a case of paralysis from acute spinal myelitis. (*f*) Certain states of the blood, *e.g.* anæmia, Bright's disease, diabetes mellitus, etc.

2. *Previous attacks.*—These in some cases, *e.g.* gout or rheumatism, exert a lasting influence on the constitution tending to favour their recurrence.

The chief *exciting causes* are :

1. Mechanical injury.

2. Chemical injury, *e.g.* any acid acting on the tissues, such as nitric or sulphuric acid.

3. Heat and cold, the effects of which are seen in burns and scalds, or in frost-bites and chilblains respectively.

4. Organised irritants, whether these are actual animal parasites, such as the chigöe, or whether they belong to the class of fungi. Among the latter is the organism which gives rise to putrefaction, and those associated with the specific inflammations.

5. Foreign bodies, whether from without, as *e.g.* a bullet, or from within, as *e.g.* an excessive collection of synovial fluid in a joint, or accumulated discharge in a wound.

Symptoms of inflammation. — These are divided into *local* and *constitutional.* They vary with the cause, the seat of the inflammation, and the constitution of the patient.

Local.—These are: 1. *Alteration in colour.* The part affected generally becomes more or less red, the intensity of the colour depending on the rapidity and freedom of the circulation through the part. Where the circulation is not free, but more or less impeded, the tendency is for the part to assume a purplish tint, as *e.g.* when gangrene is threatening. When there is biliary derangement the tendency is towards a yellow colour.

2. *Swelling.*—This is due to the effusion of liquor sanguinis, and to the migration of white blood corpuscles. It varies with the nature of the tissue inflamed, *e.g.* in dense tissues, such as bone and cartilage, there is very little swelling. It also varies with the acuteness of the inflammation. If the process be acute the swelling is soft, as in acute bursitis; if it be chronic the swelling is hard, as in the tissues round a chronic ulcer.

3. *Heat.*—The temperature in the inflamed part is raised above the normal. By some it is maintained that it is raised above that of the rest of the body at the same time, and that the blood leaving the inflamed area is hotter than that entering it. According to other observers, the rise in temperature in the part is the same as that throughout the body generally, and is dependent on it; or, it is said, if it be a little higher, the rise is so small in amount as to have no appreciable effect on the general rise of temperature in the body.

4. *Altered sensibility*, generally pain; but in the case of the organs of special sensibility pain does not express all that is meant. Thus, when the eye is inflamed flashes of light may be seen without any outward cause, and due to alteration in the special nervous sensibility of the organ. Frequently the

intensity of the pain varies with the density of the structure affected ; in other words, it varies with the capability of the surrounding tissues to adapt themselves to the increased pressure. In acute inflammation of bone or of tendon it is excessive, while in that of loose cellular tissue it is generally slight. Not only is pain felt in the part by the patient, but it is increased by external pressure, and the part is said to be *tender.*

There is also what has been termed *sympathetic pain,* where the pain is not confined to the area affected, *e.g.* pain on the inner side of the knee in hip joint disease, inframammary pain in ovarian disease, and pain at the point of the penis in inflammation of the bladder. The cause of this has not yet been satisfactorily determined, but the connection between the different painful areas is readily explained by the anatomical distribution of certain nerves.

5. *Modification of function.*—Thus an inflamed joint cannot work smoothly, an inflamed eye cannot see, an inflamed muscle cannot contract, and so on.

Constitutional.—These symptoms are generally included under one expression, *the feverish state.* As already indicated, they vary with, among other conditions, the seat of the inflammation, and thus the symptoms are more severe when such important structures as the pleura, the endocardium, or the peritoneum are affected, than in the case of ordinary inflammation of a part of the arm or leg.

The general symptoms are secondary to the local affection, and are :

(1) Rise in temperature, often accompanied by

(2) A feeling of chilliness, or what is termed a *rigor.* Although the patient feels cold, if his temperature be taken it will be found to be above normal. It goes on rising, and after a varying interval the

patient feels excessively hot. Then a profuse perspiration may break out, the temperature fall more or less, and the rigor is over.

(3) Another set of symptoms depend on the scantiness of the secretions of the body. The tongue becomes furred and unclean; there is great thirst, and a want of appetite; the bowels are constipated; the urine passed is small in amount and is high-coloured; the skin is hot and dry.

(4) Respiration and the heart's action are increased.

(5) Certain nervous complications arise. The patient complains of languor and severe headache, which may be followed by confusion of ideas going on to delirium.

These symptoms may last for a variable period. Very frequently they terminate favourably. If they do so gradually, and the temperature falls slowly, they are said to end by "*lysis;*" if they terminate rapidly, they are said to end by "*crisis.*" In the latter case it may be by some of the secretions breaking out, *e.g.* a profuse perspiration occurs, or there is a copious discharge from the bowels, or the kidneys act vigorously; in the words of the older writers, a "*critical evacuation*" may occur.

How are these symptoms produced?—In seeking an explanation three things must be kept in view.

1. There is increased general production of heat.
2. There is a general deterioration of the blood.
3. There is nature's attempt to throw off the mischief.

Increased general production of heat.—There seems to be a nervous heat-regulating mechanism in the body, the centre of which is said to be in the medulla oblongata. By this mechanism the general temperature of the body, in spite of local variations, is, in a state of health, maintained at a constant level. This mechanism may be thrown out of gear in different ways. Where there is great tension in the part and pain, the balance is reflexly disturbed, and we have "*pain*" or "*tension fever.*" By some it is held that the deteriorated blood acts directly on the hypothetical heat regulating centre, and thus disturbing the balance of the heat-regulating mechanism, acts indirectly on the tissues; by others it is maintained that the impure blood acts directly on the tissues, producing increased oxydation and tissue change, and thus leading to a general rise of temperature. Or again, other observers maintain that the primary cause is an increased local production of heat in the inflamed part. In whatever way produced, there is a general rise of temperature throughout the body, and this takes place especially in connection with the muscular and glandular systems. These are the great heat producers of the body, while the skin and the lungs may be regarded as the chief heat losers. In inflammatory fever the heat producers are abnormally active, the skin is not performing its function, and the lungs are working at high pressure to make up for the deficiency on the part of the skin. There is a general congestion of the internal organs of the body, especially of the liver, and the blood is drawn away from the skin, the great sentient surface of the body. Hence the feeling of cold in spite of the general rise of temperature.

2. **Deterioration of the blood.**—The blood circulating through the inflamed area becomes deteriorated in various ways, and as the local circulation is much increased, the blood generally becomes rapidly affected. This deterioration may be due merely to the absorption of the waste products of the inflamed area, when it gives rise to what is termed "*traumatic*" or "*waste-product fever.*" It may be due to

the absorption, in addition, of the chemical products or *ptomaines* of the organisms of simple putrefaction, when such has occurred in the wound. In this case it causes a form of septicæmia, which is variously termed "*ptomaine fever*," "*septic intoxication*," or "*sapræmia.*" Or, lastly, it may be due to the absorption of pathogenic organisms themselves (page 17), when we have another form of septicæmia, a condition which is not really *septic*, in the sense of *putrefactive*, but which is known as *septic infection*, or better, as a *specific or pathogenic infection*, including pyæmia, erysipelas, osteo-myelitis, malignant pustule, etc.

3. **Nature's attempt to throw off the mischief.**—Under this head are included the increase in the action of the heart and of the lungs, the congestion of the liver, one of the great blood purifiers of the body, and "critical evacuations" when such occur.

General principles on which the treatment of injured parts is founded.—In all injuries there is local, and, if inflammation supervene, also general unrest. The great general indication in the treatment, therefore, is to make a systematic attack on the local and on the general state of unrest.

I. **General rest** is aimed at in three ways:

(1) *By sedatives, e.g.* opium, morphia, bromides, hyoscyamus, chloral hydrate.

(2) By relief of the general vascular tension, by bleeding, either by venesection or by arteriotomy; or by general counter-irritation, so as to restore the secretions, viz. by producing purgation, diaphoresis, or diuresis.

(3) *By diet.* This must be of the simplest character, and consist mainly of milk, milk and ice, light puddings, fish, and so on. The thirst may be relieved

by cooling drinks. Of these, those that are slightly acid are generally preferred.

II. **Local rest** may be aimed at:

(1) *By bandages, splints, or weights.* Pain is often one of the best splints.

(2) *By removal of foreign bodies,* of whatever nature.

(3) *By local blood-letting,* and so relieving the tension at the seat of injury. In the early stage of congestion and dilatation the application of cold may do good. In the later stages, after stasis has occurred, it is of very little use, and may be hurtful. Then fomentations and poultices come into play, assisting the absorption of the inflammatory products, and acting as counter-irritants.

The local tension may also be relieved by position, *e.g.* by elevating the affected limb, by leeching, by incision, allowing of free escape of exudation and of blood from the part, or by cupping, either wet or dry.

(4) *By purgatives, diaphoretics,* and *diuretics,* which, in addition to their general action, also serve as local counter-irritants in relieving the local congestion.

(5) *By local counter-irritants,* e.g.* mustard, turpentine, iodine, cantharides, the cautery, poultices, and fomentations. These two last also act as local diaphoretics.

BACTERIA AND THE HEALING PROCESS.

It has already been stated that the healing process is interfered with by the occurrence of putrefaction in

* A counter-irritant is an irritant applied to a part of the body to act counter to some other irritation going on in another more or less remote part of the body. That a counter-irritant does act as such is a matter of clinical and experimental observation; but how it acts is not fully explained. It seems to act reflexly through the nervous system, influencing the vaso-motor nerves in connection with the seat of the original irritation, and relieving its congestion

the injured part, and reference has been made to septic intoxication and specific infection. We shall briefly indicate what is involved in these terms.

Sepsis, or putrefaction, is the name given to a series of changes which take place in substances containing nitrogen, under the following conditions :

1. Lowered vitality of the substance.
2. Exposure to air and water at a variable temperature between freezing and boiling point.

In the case of an open wound all these conditions are present. The vitality of the tissues is lowered, and that of a portion of them may be gone altogether. But an exposed wound, if the exposure be of short duration, may not putrefy. What, then, is the cause of putrefaction when it occurs? Some observers "attribute the process to the action of particles of dead organic matter supposed to be undergoing certain 'physico-chemical' changes, by virtue of which they start similar changes in unstable organic compounds with which they may come in contact." * By the majority of observers it is held that putrefaction is a process of fermentation, due to the presence of certain microscopic organisms of the class of fungi termed "bacteria." This is the "*germ theory of putrefaction,*" and is now almost universally adopted. Some, however, maintain, that although bacteria are inseparably associated with putrefaction, they are its accompaniment, its result, not its cause ; and that, given the putrefaction from whatever cause, the bacteria are spontaneously developed in dead decomposing matter. This involves the whole question of "spontaneous generation," into which we cannot enter here. Suffice it to say that it is almost universally agreed that organisms cannot be formed *de novo*, but arise from parents.

* "Science and Art of Surgery" (Erichsen), vol. i., p. 164. 8th edition.

The germ theory of putrefaction asserts (1) that living organisms are the cause of putrefaction; (2) that the organisms arise from parents; (3) that they are planted in the substance which putrefies; (4) that putrefaction is the result of the growth of these organisms in the substance that putrefies.

Micro-organisms may be divided into two classes, *pathogenic*, and *non-pathogenic*. Among the non-pathogenic are those which can live and grow only in dead or dying matter, and which are therefore termed "*saprophytic*." The ferment of ordinary putrefaction, the *bacterium termo*, is one of these. It enters a wound *from without*. It cannot live in healthy tissue; but if, after entering a wound, it finds there a suitable nidus, in this case dead or dying matter, it lives and grows in it, and as the result of its presence certain irritable chemical products or ptomaines are formed. These, if absorbed into the system, give rise to what has been mentioned as "septic intoxication," "ptomaine fever," or "sapræmia." The ferment of ordinary putrefaction is, therefore, limited to a certain area, and though the ptomaines may be absorbed and give rise to general disturbance of the system, there is only one seat of their manufacture, the wound.

Pathogenic or *infective* organisms, on the other hand, are associated with much more serious effects on the system. They are, in the present state of our knowledge, almost entirely included in the orders *micrococcus* and *bacillus*. They have the power, in addition to that of the saprophytes, of attacking living tissues, of spreading into them from the wound, and of growing in them at their expense. They can live in the blood and in the lymph stream. They can thus pass out of a wound into the system generally; and if, while circulating through the system, they arrive at a suitable nidus, they settle there, grow, and develop, and there produce ptomaines, thus forming a fresh centre of infection. This is a true process of infection, and has been already referred to as "specific infection."

It is possible, therefore, for a pathogenic organism to enter a wound through the medium of the tissues, though in most cases its entrance is directly from without, and is a process of direct inoculation. But it may be asked, if such an organism can attack living tissue, whence the necessity for a suitable nidus for its growth and development? Are not all living tissues liable to be attacked? And if so, why should one individual be acutely susceptible to some form of infection, while another similarly exposed goes free? To answer that health is a relative quantity, and that the power of resistance varies in different individuals, is true; but here it is a confession of ignorance. In many cases we do not know why it varies, nor can we as yet accurately define what constitutes a specific infective organism.

General principles of antiseptic treatment.—The antiseptic treatment is based on the germ theory of putrefaction. The changes of putrefaction are, according to this theory, dependent on two factors, "a living organism, and a nidus for its life; a plant, and the soil in which it is planted." Certain substances interfere with the organism causing these changes. They are termed *antiseptics*. The aim of antiseptic surgery is two-fold: (1) To conduct a case so as to prevent putrefaction. (2) To remedy putrefaction when it has occurred. We may try to attain this by acting on the plant, or on the soil, or on both.

The different methods of interference are:

1. By preventing the deposit of organisms.

2. By removing them, if deposited, before they have had time to do harm, *e.g.* by washing out the wound.

3. By killing them, inside the wound, or outside of it.

4. By removing the soil in which they flourish, *e.g.* by free drainage.

5. By rendering the soil inert. This may be done constitutionally by increasing the vitality of the tissues, by bringing the patient into as good a state of health as possible before operation. It has also been attempted by the administration of certain drugs, *e.g.* carbolates.

Locally, it may be done by preventing tension, by lowering the temperature of the tissues, by dry dressings, and by rapidly changing the wound from an absorbing to a casting off surface, *e.g.* by means of a poultice (Savory).

Such are the principles of antiseptic surgery, and the general lines on which they are sought to be carried out. The details will be considered in the next chapter, on Wounds.

II. WOUNDS.

PROF. JOHN CHIENE.

Classification.—A wound may be defined as "a solution of continuity in any part of the body." Wounds may be divided into two classes: the truly *subcutaneous*, without division of the skin, and the *open*, with division of the skin.

Open wounds are further subdivided in two ways. 1. As regards the manner in which they are inflicted, they are looked upon as *incised*, *lacerated*, *contused*, or *punctured*. 2. With reference to their method of healing, they may be regarded as open wounds (*a*) *with loss of substance*, and (*b*) *without loss of substance*. Poisoned wounds will be discussed in the chapter on Animal Poisons (vol. i., page 547).

Of the **subcutaneous wound**, when there has been no division of the epidermis, and consequently no exposure to the air, little need be said here. As examples we have what is known as a *contusion*, or bruise, when occurring in the soft parts, and a *simple fracture* when occurring in bone. These will be fully considered under Contusions (vol. i., page 40) and Fractures (vol. ii., page 1). As regards the process of healing, however, it may be noted here that it may be one of simple absorption, as in a black eye. In other cases, if the clot be not too large, and not irritated, it will, with proper treatment, pass through the changes described in the preceding chapter. If it be objected to this that, *e.g.* in the case of a black eye, the clot does not remain as a mass of tissue, we would answer by referring to the great tendency, in all natural processes of repair, to return to the original state as far as possible. It is on this principle that we have the absorption of effusion, and the rounding off of sharp points after fracture; and if it holds good with regard to a bone of twenty, thirty, or forty years' standing, or even of greater age, how much more likely is it to act in the case of a rudimentary structure such as a clot, whose existence is reckoned by hours, not by years?

This class does not include such wounds as that made in tenotomy, where there is merely a small opening in the skin, and which are sometimes termed subcutaneous.

The open wound with loss of substance.—Here there is necessarily a certain amount of exposure to the air. Take a simple case, as *e.g.* where a small piece has been cut off from a finger, and suppose that the exposure has been short, so that putrefaction is prevented. Any simple dressing, such as a rag rolled round the part to keep it at rest, and to act as a receptacle for the coagulating blood, and prevent the access of air, will do. If the rag be removed too soon (it may be to see if the bleeding has stopped), the clot that has formed will probably break down. Leave the part at rest, and what occurs? A clot forms, and its surface, drying, forms a scab, which protects the clot underneath. Vascularisation of the clot occurs, and in that part in connection with fibrous tissue, fibrous tissue is formed, while in that part lying next to the epithelial tissue of the edges of the surrounding skin, epithelium is formed, and grows inwards until the whole wound is covered over by dry epithelial tissue. The scab, not being retained in its place, then falls off. Should there be any tension under the scab, *i.e.* should the effusion be in excess of the absorption, the process of cicatrisation, as it is called, does not go on so satisfactorily, but the clot breaks down, and suppuration takes place under the scab.

If we next take the case of a shallow wound, where the exposure has been longer, and putrefaction has occurred, then the clot breaks down, liquefies, and a gap is left with no clot in it. If this exposed surface be watched, it is seen to become moist. From the dilated vessels there is poured out on it the liquor sanguinis, and the white blood corpuscles migrating, we have all the conditions necessary for the formation of the colourless clot, which now forms as a greyish film on the surface. In the words of the older writers, the surface becomes glazed. The next change to be observed is the appearance in the greyish film of little red points here and there. These increase in number, and, coalescing, extend so as to cover the whole surface. The little red projections are vessels, and are termed "*granulations.*" The whole surface has become vascular. So long as the granulations persist, there is an exudation from the wound of pus; but the granulation tissue is simply vascular lymph, and we have seen that in the process of repair such lymph tends to become like the tissue in which it lies. Accordingly, in the deeper parts of the wound fibrous tissue forms and contracts, and *deep cicatrisation* occurs; while at the edges epithelium grows in and covers the surface, and *superficial cicatrisation* takes place. In simple language, a *scar* is formed. This method of healing is termed healing by "*granulation*," or by "*second intention.*" The formation of the fibrous tissue and its contraction must proceed *pari passu* with the ingrowth of the epithelium if a good result is to be obtained. Otherwise we have a depressed scar or a weak one respectively, as the deep or the superficial cicatrisation is the more rapid.

If the wound be not shallow, but a deeper trench-like wound, it heals by the growing together of the granulations at its deeper part, and the process gradually extends towards the surface, until the wound becomes superficial, when superficial cicatrisation occurs. The dangers which the surgeon has to contend with in such a case are the growing together of the granulations near the surface of the wound, and the union of the skin edges before the deeper parts of the wound are firmly united. To prevent this, the superficial part of the wound must be kept open to allow of gradual healing from below upwards. To this method of healing by granulation, the special term of "*coaptation*" may be applied.

The open wound without loss of substance, or more accurately without *appreciable* loss of substance, as *e.g.* in the case of a clean cut or incised wound. Here, if the surfaces be brought at once into gentle contact and kept there, there is formed between them a thin layer of coloured clot, which passes through the changes already described, and forms the bond of union between the two surfaces. To this the name of healing by *first intention* has been given. A method of healing by "first intention" was described in 1838, by James Macartney, of Dublin. It was the direct growing together of the opposite surfaces "without any intervening substance such as blood or lymph." There can be no doubt now, that in every incised wound the injury to the tissues is sufficient to lead to the formation of a layer, however thin, of clot between the two surfaces, and that healing by Macartney's immediate union never takes place.

If the surfaces be *not* brought at once into contact; if, for example, hæmorrhage occurs a few hours after an amputation and the surgeon, having opened up the wound and stopped the bleeding, does not bring the flaps together again until after the surfaces have become glazed, what happens? The two layers of colourless clot undergo the same changes as the layer in the incised wound, with this difference, that while the surfaces were becoming glazed the coloured corpuscles were got rid of, and union takes place with greater ease. This method is termed healing by *apposition*, and is really a most excellent form of healing by first intention. Healing by apposition differs from healing by coaptation in this; that in healing by apposition the surfaces are brought together *before*, while in healing by coaptation they are brought together *after* the colourless clot covering them has become vascular.

Skin grafting.—By this is meant a transplanting of skin on the surface of a granulating wound or ulcer. It is in reality, generally, a process of epidermis grafting rather than of skin grafting, and was first introduced by Reverdin. According to this method little islands of epidermis are, so to speak, set down throughout the granulation tissue, in the hope that as the epithelium grows in from the edges, so it will start from each little island of epidermis as a focus, and that thus *superficial cicatrisation* will be hastened.

The operation is done in this way. A thin shaving of epidermis is taken, and is cut up into little bits, each about the size of a pin head. Some surgeons lay these on the granulating surface. It seems better to sink them a little into the granulation tissue. You lose sight of them for a few days, and then you see little points here and there which gradually get bigger, and regular islands form, each acting as a centre of growth of epithelial tissue over the surface of the wound. Care has to be taken not to hasten unduly the process of superficial cicatrisation. The formation of fibrous tissue and the accompanying contraction in the deeper part of the wound must proceed *pari passu* with the growth of epithelium, in order that a healthy scar may result.

Open wounds may also be divided into *incised*, *lacerated*, *contused*, and *punctured*.

I. An **incised** wound is a clean cut, such as that made with a sharp instrument. An apparently clean cut may, however, be made by a blunt instrument, as in the case of a kick with a heavy boot. This is especially apt to occur over bones, and if the line of impact be linear. The symptoms are: hæmorrhage, gaping of the wound, and pain, frequently severe. In incised wounds the aim of the surgeon is to procure union by first intention. He will fail, however, to do so if the wound be exposed to any fresh source of irritation, of whatever nature.

II. A **lacerated** wound is, as the name implies, one in which there is more or less tearing of the tissues, and consequent irregularity of the sides and edges of the wound. Such wounds present an infinite variety of form, depending on the way in which they are inflicted. A lacerated wound does not gape so much as an incised one. The strain on the tissues in its production is much greater than in a clean cut. Hence, there is always more or less "ecchymosis" or *hæmorrhage in the surrounding tissues.* Their vitality, too, suffers a greater amount of depression, and there is great tendency to sloughing. Owing to the tearing across of the vessels, the natural arrest of hæmorrhage occurs more readily, and the bleeding from the wound is slight. Lacerated wounds are very frequently also contused.

III. A **contused** wound is one where the edges are bruised, and their vitality destroyed. It is always associated with a certain amount of ecchymosis.

The pain in a lacerated or in a contused wound is generally of a dull aching character. The method of healing in these wounds is that by "granulation" or "second intention." The dead tissue is absorbed, or separates as a slough, leaving an area of granulation tissue, which undergoes the changes already described.

IV. A **punctured** wound is one made by a pointed instrument. Its depth is much greater than its breadth. On account of its depth it is one of the most dangerous forms of wounds. While the aim here is to obtain union by "first intention" if possible, owing to the variety in the contractility of the tissues through which it passes, the consequent difficulty in keeping the surfaces in accurate contact, and the tendency, therefore, to accumulation of fluid and tension, on the one hand, and the difficulty of drainage on account of the depth of the wound and its small external opening on the other hand, union almost always takes place by "second intention." The great point to attend to in the treatment is free drainage. At one time this was done by enlarging the wound. It is now done by the use of a drainage tube.

Defects in the healing process.—These have, for the most part, been already considered under inflammation and the methods of healing. Their causes are constitutional and local. Those due to a *constitutional* cause show themselves in the form of a want of the power of repair giving rise to slow or to partial healing, or even to absolute want of union. The *local* defects are those due to the causes of inflammation. In the case of union by "second intention," the granulating wound is practically an ulcer, and the diseases of granulations will be treated of in the chapter on Ulcers (vol. i., page 60).

Treatment of wounds.—In the treatment of any wound the surgeon endeavours to prevent inflammation, and to get as early and as painless a union as possible. The great principle on which the treatment must be based is *rest*, local and general. The main indications of treatment on this principle are :

1. Stop the bleeding.
2. Remove foreign bodies.
3. Bring the edges and surfaces of the wound in contact, and keep them there.
4. See that there is free drainage.

5. Steady the part.

6. Avoid putrefaction.

1. **Arrest of hæmorrhage.** — The artificial arrest of hæmorrhage is described in Art. xxv., vol. i.

2. **Removal of foreign bodies.**—This may most effectually be done by washing out the wound with water to which some antiseptic solution should have been added. By this means dirt, portions of coagulated blood, etc., are got rid of. Bodies firmly embedded in the tissues must be removed by *clean* forceps.

3. **Apposition of edges and surfaces.**—This may be done in many ways.

With reference to the *edges.* Some surgeons use adhesive plaister of some kind. This method is often of service in small wounds. In larger wounds its chief disadvantages are, that unless very carefully applied it is apt to cause inversion of the lips of the wound. It is not easy to keep it aseptic. It is difficult of application unless the parts are thoroughly dry; and it is apt to cause tension.

A preferable way is to use some form of stitch or *suture.* Sutures vary in their form, and in the materials used in making them.

The principal materials are *silk*, *silver wire*, *catgut*, and *horse-hair.* Silk is open to the objection that it is flexible and yields, whereas the object is to keep the part quiet; and if the silk stitch be made sufficiently rigid by drawing it tight, tension is apt to occur in the wound. Silver wire meets all these objections; but there is difficulty in removing it without causing pain. Catgut makes a good stitch so long as it remains rigid, but as it is gradually absorbed, and is apt to be softened more quickly than is sometimes expected, it, like silk, also yields. Horse-hair has all the advantages of a good stitch. By using it double, all the required strength may be generally obtained, and its resiliency is an advantage, as it permits of a certain amount of giving, and consequent relief if tension occurs. It forms, so to speak, a little rigid yet elastic circle, and it can be easily removed.

Apart from the material used, a suture may be applied in various ways. The chief are (1) the "*continuous*," or "*uninterrupted*," suture, when the stitches are made with one unbroken thread, and which is useful where very accurate apposition of the edges is required, as *e.g.* in wounds of the intestine. (2) The *interrupted* suture, the commonest method, where the edges are brought together by a series of separate single stitches. When the edges can only be brought together by being stretched, *e.g.* when a portion of diseased skin has been removed, and where, in other words, there would be tension of the edges of the wound, this can be lessened by passing the knife under the skin round the wound, thus rendering the flaps looser and capable of more easy approximation; and by "*superficial button sutures*," sometimes termed "*stitches of relaxation*." Two small thin sheets of lead are used, each with a hole in the centre. One is threaded with silver wire, which is passed through the skin at some distance from the edge of one flap, and is brought out at a corresponding point on the side of the opposite flap. The other button is then fixed on, and so the edges are brought more closely together.

The *surfaces* of the wound, however, must also be brought into contact and kept there. The importance of this cannot be too highly estimated. If, for example, after the operation for excision of the female mamma, the edges of the wound alone are brought together, what happens, if reactionary hæmorrhage comes on? The blood collects between the skin and the pectoral muscle, and all the more so if the edges are in accurate contact. And apart from any hæmorrhage, there is always more or less effusion, whieh, aeeumulating, will give rise to tension. It may be said that efficient drainage will eorreet all this, but the primary use of a drainage tube is prevention rather than eure, at all events in a recent wound. The best way of seeuring adaptation of the surfaces, and of supporting them in that position, is to apply suffieient and aeeurate pressure. In the ease taken as an example, pads must be applied on either side of the wound, and the arm bandaged to the side. The pad should be made of some semi-elastie material such as wadding, and the bandage should also be semi-elastie, *e.g.* a domette bandage, to seeure eonstant though not too great pressure. "*Deep button sutures*" are also of great serviee here. They differ from superficial button sutures only in the faet that the silver wire passes deeply into the tissues.

4. **Free drainage.**—The importanee of free drainage is evident when the eonsequenees of its negleet (tension, suppuration, ete.), are remembered. The need for drains to conduet away diseharges from a wound is lessened the more accurately the surfaees are brought in contaet. Drainage may be seeured by using tubes of indiarubber, or of decalcified bone, or skeins of eatgut or of horsehair; but whatever form of drain be used, eare must be taken that the outer end of the drain be in as dependent a position as possible. If a tube be employed, its outer end should be praetieally on a level with the edges of the wound, and the tube must be prevented from passing baek into the wound. This end may be attained by transfixing the outer end of tube with a piece of silver wire. As the wound heals, the tube requires to be shortened, and a wound on this aeeount may require to be dressed more frequently than would otherwise have been neeessary. The time that the tube remains

in varies with the size of the wound, with the rapidity of the healing, and with the amount of discharge. The sooner the tube is out the better; but care must be taken not to remove it too soon, as there is danger of tension occurring in the deeper parts of the wound. Tubes are more reliable than catgut in large wounds, because the catgut is capable of being absorbed by the tissues, and may be absorbed too soon, or may otherwise prove insufficient. Catgut is especially useful if the discharge be serous in character; not if it be purulent, for catgut cannot convey pus. If catgut be used, it is stitched to the deeper parts of the wound, or the ends of catgut ligatures used in the wound may be brought out at the end of the wound, and act as a drain. The catgut must not be allowed to get dry, or its capillary action is lost. Free drainage may be further obtained by leaving the wound open, or by placing some absorbent material outside it, which sucks up the discharge as it reaches the surface, and prevents accumulation in the deeper parts.

5. The part must be **steadied** by some form of splint, using "splint" in its general signification. This may be done by means of pads, bandaging, ordinary wooden or metal splints, or by appending a suitable weight. A sheet of lead, adapted to the under surfaces of the limb, is often of great use in amputations in steadying the part.

6. **Putrefaction** must be avoided. How this may be attempted has already been considered (page 19).

The various Forms of Dressing applied to Wounds, including the Antiseptic Treatment.

I. **The occlusion** method consists in applying some adhesive material over the wound, to close it after its surfaces and edges have been adjusted. The disadvantages of this method have been already discussed in connection with the use of sticking plaister in the treatment of wounds (page 28).

II. **The open** method consists in leaving the wound free from any form of dressing whatever. This method permits of all the indications for the proper treatment of a wound being fulfilled, except one, the avoidance of putrefaction. The wound being open, *ceteris paribus*, drainage is provided for, while exposure to the dry air assists in drying the wound, and so in lessening the chances of decomposition in the discharges from the wound. But should the drainage be imperfect, should any of the secretions collect in any little pocket in the wound, no provision is made under this method for their protection from septic influences.

III. **Simple water dressing** consists in the application to the wound of a piece of wet lint which is covered with a piece of oiled silk to prevent evaporation. This method was used by Liston with great success, even large wounds often healing with very little or almost no suppuration. The secret of success here is that free drainage is allowed, but this method, too, is open to the objection that even "pure water" is surgically more or less unclean, and its use may give rise to the implanting of the causes of putrefaction in the wound.

IV. **The dry dressing** is on this account preferable to the wet dressing. It consists of a pad of dry lint placed on either side of the wound so as to secure thorough apposition without interfering with drainage. Some more dry lint is placed over these, and the whole is surrounded by a bandage. Cotton wool is sometimes substituted for lint. This dressing is useful in small wounds, union by "scabbing" generally taking place. In large wounds it is permissible only after free drainage has been provided for; and even then is not advisable on account of the liability to the occurrence of putrefaction.

V. **The antiseptic treatment.**—We have seen, therefore, that while each of the above methods of dressing fulfils many of the indications for the proper treatment of a wound, none of them makes any attempt to provide against the entrance into the wound of the causes of putrefaction. Free drainage, cleanliness, and rest are certainly important factors in the prevention of putrefaction, but they cannot prevent the entrance of bacteria into a wound. This can only be attempted by the use of antiseptics. The word antiseptic must now be taken as having a much wider meaning than it used to have. It cannot be limited to its strictly etymological signification, much of what was formerly ascribed in general to sepsis or putrefaction being now known to be of quite different origin, and to be, in relation to the organism, distinct from those of ordinary putrefaction. As the action of micro-organisms on the tissues is apparently through a process of fermentation, antiseptic must now be held as synonymous with anti-fermentative. It is impossible here to enter into the relative claims of the various antiseptic substances in use. A perfect antiseptic should be sufficiently strong, volatile, and non-irritant. Such a substance has not yet been discovered. The two antiseptics in most general use in surgery are carbolic acid, which is used in the strength of 1 part of absolute phenol to 20 or 40 parts of water, and perchloride of mercury, used in the strength of 1 to 2,000 or 1,000 of water. There are many other preparations of these substances. Carbolic acid is irritant and volatile; perchloride of mercury is non-irritant, but has the disadvantage of being non-volatile.

The materials used as dressings are:

1. *Carbolic gauze*, which was the original form of dressing used by Lister. It is made by charging

unbleached muslin with a mixture consisting of crystallised carbolic acid, 1 part, common resin and solid paraffin, each 4 parts.

2. *Eucalyptic gauze*, where eucalyptus oil is substituted for carbolic acid.

3. *Salicylic cotton wool*, *salicylic silk*, *corrosive wood wool*, *sublimated wool*, *i.e.* some form of absorbent wool impregnated with some antiseptic.

4. *Protective*, or oiled silk coated on either side with a thin layer of copal varnish, so as to render it impervious to the carbolic lotion. Over this again a fine layer of carbolised dextrin is laid, which allows the 1 to 40 lotion, into which the protective is dipped immediately before use, to wet and so thoroughly purify the surface. Its use is to protect the edges of the wound from the irritating carbolic acid, and to prevent the sticking of the dressing to the wound.

5. *Mackintosh*, or thin cotton cloth covered on one side with indiarubber.

Having thus briefly considered some of the chief materials employed, let us illustrate how they are used in attempting to carry out the great principles of the antiseptic treatment.

1. **Methods.**—In a wound made by accident, and which has been exposed for some time to the air before the surgeon sees it, the first step, after arresting the hæmorrhage, is to thoroughly purify the wound by washing it out with some antiseptic solution, *e.g.* 1 to 40 or 1 to 20 carbolic lotion, the strength of the lotion used varying with the length of exposure of the wound. The skin round the wound must also be purified. Then a drain, if required, is inserted, and the edges and surfaces of the wound adjusted and secured by some form of suture, *e.g.* carbolised horsehair. A piece of protective is placed over the wound, and, if a catgut drain be used, also over the ends of the catgut to prevent it from becoming dry, and so

losing its action by capillarity. If a tube be used, the protective must be cut so as to leave the end of the tube open. A layer of wet carbolic gauze is placed over the protective (wet gauze, because dry carbolic gauze, unless it be warm, is not antiseptic). This finishes the deep dressing. Then follow, according to the ideas of the surgeon, pads of dry carbolic gauze, or of some absorbent antiseptic wool, above which is placed the large superficial dressing, consisting of eight layers of gauze, with or without a sheet of mackintosh beneath the outermost layer. The superficial dressing is not wet. As it becomes warm with the heat of the body, the volatile carbolic acid with which it is impregnated is set free. The object of the mackintosh is to distribute the discharge when it reaches it, and so prevent it from soaking too quickly through the gauze, and from consequent exposure to the air. Though it is of service when there is a great amount of discharge, it has the disadvantage of preventing free evaporation, and thus of rendering the parts sodden. A gauze bandage fixes the dressing in position, and, when further support is required, an elastic or a domette bandage may be used.

2. In the case of an operation, the first consideration is the thorough purifying and keeping clean of the hands of the surgeon and of his assistants, of the part about to be operated upon, and of the instruments, sponges, ligatures, etc., to be used. Round the part are laid towels soaked in some antiseptic solution. On these the instruments, sponges, etc., which are thoroughly soaked in 1 to 40 carbolic lotion, may be laid with safety during the operation. Mere washing with carbolic lotion is not sufficient to thoroughly cleanse the skin. The part should be soaked for some hours before the operation, and thus the carbolic acid is able to permeate the follicles of the skin and destroy any causes of putrefaction that may already exist there.

Ether, iodoform, and turpentine are also used for the preliminary purification of the skin. But the skin and wound must be kept pure. This is aimed at in different ways. The two chief methods are *irrigation* and the carbolic *spray*. By many the spray is regarded as the one essential of the antiseptic treatment. It is not so. It is only one of the ways, though one of the best of them, in which the principles of the antiseptic treatment are carried out. Both in irrigation and in the use of the spray, the aim is to keep the clean surfaces covered with some antiseptic material, and thus to prevent them from becoming surgically unclean. In *irrigation* this is generally done by using a mixture of glycerine and carbolic acid, or a solution of corrosive sublimate. Irrigation was formerly used by Lister, and was displaced by the spray, which he found more effective. The tendency now seems to be a return to irrigation, the reason probably being the difficulty of using a spray in general practice. The advantages claimed for the spray are, that it is the best irrigator; and that it forms an antiseptic atmosphere, so to speak, in the immediate vicinity of the wound. If the spray be used, it is turned on immediately after the cleansing of the skin, and before the incision is made, and it is kept on till the superficial dressing is applied. The dressings have been already described. It should be added, however, that if the mackintosh be used, care must be taken not to let it be perforated in any way, *e.g.* with a pin, or its aim will be defeated. The principles of the antiseptic treatment, and some of the more salient points of its detail, have here been briefly indicated.

Complication of wounds and their treatment.—1. *Hæmorrhage.* (*See* Art. xxv.; vol. i., page 350.)

2. *Severe pain.*—This may be relieved by the use of sedatives. Opium, and especially the subcutaneous

injection of morphia, are the best. Relief must also be sought by treating the local cause of the pain.

3. *Starting of muscles* in consequence of their being stimulated reflexly by the severe pain. This is to be remedied by opium, by placing the limb in such a position as to relax the affected muscles, or by applying a weight so as to steady the limb.

4. *Foreign bodies*, aseptic or septic. These must be removed if possible. A good general rule is, "only attempt to remove a foreign body if you can feel it."

5. *Shock.*—This is discussed in Art. IX. (vol. i., page 121).

Cicatrices.

A cicatrix may be defined in general terms as the result of the process of repair in a wound. The term cicatrix or scar, however, is not generally used in connection with the healing of true subcutaneous wounds, whether of the soft or of the hard tissues of the body. It is usually applied with reference to wounds associated with a gap or breach in the continuity of the surface of the body; the term surface being taken in its widest sense as any part exposed to the air.

The process of cicatrisation is that which finally seals the wound, whatever be the method of healing, whether it be by first or by second intention. The resulting scar consists of a deeper or fibrous tissue portion, and a superficial or epithelial portion. It is nature's best substitute for the original tissue, but it is not exactly the same. The deeper portion contains no lymphatics, and owing to the absence of yellow elastic fibres, and to its being denser than ordinary fibrous tissue, it is of a more or less rigid unyielding character. In the superficial portion there are no sweat glands, and as the papillæ and hair follicles are absent, the scar feels smoother than the surrounding skin. A recent scar is redder than normal, owing to its abundant vascular supply; but as it grows older the blood-vessel becomes obliterated, and the scar becomes white and opaque. There is also a tendency for the induration to become less with age, and for the scar to become more like the tissue in which it lies. A scar usually contains but few nerves, and often none at all.

Morbid cicatrices.—When the cut end of a nerve, which is frequently bulbous in form, is involved in a cicatrix, the result is a very *painful* one, owing to the pressure exerted on the nerve by the contracted unyielding fibrous tissue. Where, as in a burn, the injured area is much greater in its superficial extent than in its depth, there is great tendency to marked *contraction* of the cicatrix, giving rise very frequently to great deformity. Thus the chin may be dragged down as the result of the contraction of the cicatrix after a burn of the neck, or the arm may be fixed to the side from the same cause after a burn in the region of the axilla (Fig. 6, page 194).

Sometimes, especially in children, in the formation of a scar there is *excessive* growth of the new tissue, resulting in nodular masses which, being formed of cicatricial tissue, are hard and smooth. Not unfrequently they are very vascular. There are the so-called "*warty*" growths of cicatrices. Resembling these somewhat in appearanee is the fibrous tumour found especially in the eicatrices of burns and scalds, and termed "*cheloid*" (χηλη, a claw). It is not connected with the formation of the scar, and may occur in it years afterwards. It forms a flattened tumour, frequently overlapping the skin at its margin, and has what has been described as a "tied down" appearance. The growth is limited to the skin, it spreads along the fibrous sheath of the vessels, and frequently has a more or less claw-like form; hence the name cheloid.

A *weak* scar is the result of the process of superficial cicatrisation taking place more rapidly than the formation of fibrous tissue, and its contraction in the deeper part of the wound. Owing to the diminished vitality, and therefore diminished power of resistance in a scar, it is liable, when irritated, to give way more easily than normal tissue, and to ulcerate. The epithelial tissue of the scar may take on an excessive growth of a malignant character, invading the deeper tissues, and form, in short, an *epithelioma.*

Treatment.—*Painful cicatrices* may be treated by division of the cicatricial tissue pressing on the nerve, or by division of the nerve itself if it be known, or by excision of the so-called "neuroma," *e.g.* of a stump. In treating the deformity arising from the *contraction* of a cicatrix, especially when a plastic operation is required, the surgeon must be guided by the requirements of the special case. The chief indications are that the cicatrix must be carefully but thoroughly divided, and dissected off from the structures beneath. The part must be restored to its normal position as nearly as possible, and means adopted to prevent contraction recurring. Transplanting of a healthy flap of skin may be required, or skin grafting may be of use.

The *warty* growths, as a rule, had better be left alone unless they give rise to heat and tingling. If so, they may be treated by applying some form of local counter-irritation, or by removal.

A *cheloid* tumour should not be interfered with by operation, for, depending as it does on a constitutional condition, it is most liable to return in the new scar. Further, after reaching a certain size it generally ceases to grow. Locally some sedative plaister may be applied if there be any irritation. The constitutional treatment does not seem to be satisfactory.

Malignant tumours are to be treated by free and early removal.

III. CONTUSIONS.

AUGUSTUS J. PEPPER.

A CONTUSION may be defined as a laceration of tissue without breach of surface continuity. When the skin or mucous membrane is broken the injury is known as a *contused wound.*

The extent of the lesion varies from slight extravasation into the skin to rupture of trunk vessels and nerves, and even fracture of bones. The force may be applied *directly*, the part being squeezed or struck; or *indirectly*, *e.g.* when the spine is contused by a fall upon the shoulders. The quantity of blood effused depends upon: 1. The degree of violence. 2. The number and size of the vessels implicated. 3. The laxity of the tissues. 4. The proximity of resisting structures. Thus the effect of a blow upon the skull or shin will be very different from that of one inflicted on the fleshy part of the thigh. Again, the less the elasticity of the skin the more marked will be the contusion. 5. The tendency to bleed; this is very pronounced in the subjects of hæmophilia. It is also increased by degeneration of the blood-vessels, whether from age or disease.

The extravasated blood is known under different names. When it is widely diffused along the subcutaneous or intermuscular cellular planes it is called a *suggilation;* when moderate in amount and limited in distribution, an *ecchymosis* (the latter term is employed chiefly in reference to surface contusions); when profuse and circumscribed, forming a more or less obvious swelling, a *hæmatoma.* Familiar examples are furnished respectively by: 1. Hæmorrhage into the loose areolar tissue of the scrotum. 2. An ordinary "bruise" of the skin. 3. An accumulation of blood beneath the scalp.

In subcutaneous lacerations the greater part of the extravasated blood is derived from the veins, for the arteries, being stouter and more elastic, are better able to resist injury.

Contusions of vessels.—In addition to the inevitable rupture of numerous small vessels, the main trunks are occasionally torn, and this is the more likely to occur where the contusing force acts immediately over a bone; *e.g.* the brachial artery may suffer partial or complete rupture through the arm being caught between two buffers.

In some cases of simple fracture, especially of the leg, a large artery may be lacerated by a splinter of bone. Subcutaneous hæmorrhage, although it may be profuse, is not immediately fatal, unless it happens that the blood escapes into a cavity, like that of the pleura, for the tension of the surrounding structures, together with the pressure of the extravasation, tends to check the bleeding; moreover, the wound in the vessel being a lacerated one, it does not gape, and the shreds of the vascular walls and sheath not only offer a mechanical obstacle to the bleeding, but, acting as foreign bodies, they induce coagulation.

When an artery is only partially ruptured hæmorrhage does not ensue directly upon the injury, but it may come on some days later; the bruised tissue, which in the meantime has undergone degenerative softening, giving way under the blood pressure. On the other hand, thrombosis may occur at the seat of injury, and the lumen be permanently occluded, the same as after ligation; or lastly, the wall of the artery having lost its elasticity and power of resistance, may become stretched, and form the sac of a circumscribed traumatic aneurism.

As regards contused or lacerated veins, it may be said that the chief danger lies in the subsequent phlebitis; with its possible sequelæ, *i.e.* suppuration and dislodgment of clots. The walls of a vein being readily compressible, and the blood pressure within being much less than in an artery of corresponding size, hæmorrhage is more easily restrained. But if one of the large serous cavities is opened at the time of the accident, a fatal result may quickly supervene. I have seen two cases of hæmo-thorax from subcutaneous laceration of a vein; in one, a portion of a fractured vertebra wounded the vena azygos major; in the other, the subclavian vein was punctured by a fragment of a broken clavicle.

It should be borne in mind that the force which lacerates a trunk vessel is certain to rupture many smaller ones in its vicinity, and for this reason the danger of gangrene is greater than would at first sight appear; *e.g.* a child had its arm squeezed in a gate, and the brachial artery was contused in two places, the inner and middle coats being torn from the outer. The injury was quickly followed by occlusion, from thrombosis, and this, in conjunction with rupture of numerous subcutaneous and intermuscular veins, caused complete stoppage of the circulation and death of the limb (Art. xxv.; vol. i., page 350).

Contusions of nerves.—The nerve trunks are rarely injured severely in subcutaneous lacerations, since, for the most part, they lie deeply, and are well protected by the soft parts. The chief exceptions to the rule are the ulnar nerve, just above the elbow; the musculo-spiral, at the outer aspect of the arm; and the peroneal, below the head of the fibula. Contusions in these situations not uncommonly cause a certain amount of paralysis, from bruising or partial tearing of the nerve involved. But, apart from these serious lesions, the nerves also suffer from the effects of the *concussion* in the same way as the brain and spinal cord. The molecular disturbance in the axis cylinders causes temporary diminution or abolition of conductivity, so that sensation and motion are for the time impaired or lost in the areas of distribution of the injured nerves. It is possible that violent concussion of a limb may be the starting point of secondary peripheral degeneration of the nerves. Contusion of a nerve, short of complete destruction, causes at first a feeling of numbness at the spot and along the distal course of the nerve. This is succeeded by a burning pain. The pain may be very severe, in fact it may bring on syncope. But fainting may also arise in a reflex manner, the brain suddenly becoming anæmic from contraction of the arterioles, the result of powerful stimulation of the sensory nerves. The immediate effect of concussion or contusion of a nerve will vary according to the seat of injury; *e.g.* the functional disturbance is greatest when the large sympathetic plexuses are involved (Art. XXIX.; vol. i., page 498).

Contusions of muscles.—When a muscle is extensively lacerated there is copious bleeding, for the tissue is richly supplied with vessels. In complete rupture the ends become widely separated, owing to contraction of the muscular fibres, and the interval is soon filled with extravasated blood. Volitional control is lost; in short, the muscle is for some time powerless for action.

It is worthy of note that contusions of all living tissue elements diminish their vital activity, and as the condition may be long enduring, it has an important bearing on the question of regeneration. This is best exemplified in the case of the nerves, for their repair largely influences the nutrition of the structures supplied by them.

Diagnosis of contusions.—The effect of a contusion is known to some extent at once by the state of the vessels and nerves. The surgeon is further guided by the course of events. When the blood is effused into the skin it assumes the form of spots and streaks, and presents a dull red appearance. The colour of the blood is also manifest in extravasations beneath the conjunctiva. Subcutaneous hæmorrhages give a steel-grey or purplish tint, according to the thickness of the skin. When an artery of considerable size has been lacerated there may be pulsation of the seat of injury, and a loud or subdued bruit. The bruising becomes more marked a few days after the injury, owing to the staining by the hæmoglobin set free from the blood corpuscles and taken up by the fluids which permeate the tissues. For the same reason the discoloration is more widely distributed than the laceration of the vessels. An ordinary bruise takes from one to three weeks to disappear, and during this time the colour changes from red, reddish-black, green, to lemon yellow.

Hæmatoma.—A hæmatoma is a collection of blood surrounded by lacerated tissues. It is well seen in extravasations beneath the scalp and pericranium. At first it is soft and fluctuating throughout, then it becomes firmer, from coagulation of the blood within, and inflammatory effusion around. Later on it may regain its fluid condition from liquefaction of the clot, the contents being then of tarry consistency and colour. At this time its margin, which is well defined, gives a crateriform character to the swelling, the finger passing over an incline, and then suddenly falling down a steep declivity. This is most marked in cephalhæmatomata.

Changes in hæmatomata.—These are: 1. Absorption. 2. Suppuration. 3. Decomposition. 4. Encapsulation, with concentric lamination throughout, the fluid part of the blood being absorbed. 5. Cystic degeneration, especially in firm tissues like the brain. 6. Calcification, which is very rare.

Absorption is by far the most frequent event. Suppuration may arise either from the severity of the injury or from the introduction of septic matter. As permanent vestiges of contusions we may find orange or ruby-red crystals of hæmatoidin, and groups of black granules of colouring matter, and tracts of cicatricial tissue.

Treatment. — Unless specially contra-indicated apply gentle pressure; this checks the hæmorrhage, and favours the absorption of blood. In the early stages employ cold continuously. In the event of acute inflammation poultice the part. If suppuration takes place open antiseptically. If the hæmatoma be very large or persistent, drain off the fluid contents with the aspirator, and if this fails it may be advisable to lay open the tumour and let it heal by granulation. Under all circumstances enjoin rest.

Brush burn.—This is produced by some part of the body coming in contact with an object in rapid motion, such as the straps of machinery. The surface of the skin is excoriated, and the tissues beneath formed into an eschar.

Treatment.—Protect the wound and apply iodoform ointment.

Traumatic malignancy.—There can be no doubt that in many cases mechanical irritation is the sufficient cause of epithelioma and other forms of true cancer, and it is highly probable that connective tissue tumours may own a similar origin. That a contusion is sometimes the determining factor in the development of sarcomas is beyond speculation. The only question being whether there exists a special predisposition to malignancy, or merely an instability of nutrition, which in one case leads to inflammation, and in another to a new growth. My experience leads me to adopt the former theory.

IV. ABSCESS.

Augustus J. Pepper.

Nature and varieties of pus.—Pus, the product of suppuration, varies in appearance and composition according to the conditions under which it is formed. That obtained from a simple acute abscess, or from a healthy granulating sore, is a fluid of creamy consistence, and of yellowish white colour. As it presents no special evidence of constitutional disease or of complication of the local inflammatory process, it is termed *laudable.* Its specific gravity is from 1030 to 1033. When freshly secreted it is alkaline in reaction. With liquor potassæ it gives a gelatinous mass. It contains from ten to fifteen per cent. of solid matter, and of this about two-thirds is albumin. Of the other third one-half is fatty matter with traces of cholesterine, whilst the remainder consists chiefly of salts like those of blood serum, chloride of sodium predominating. Tyrosin, leucin, and other nitrogenous derivatives are present in minute quantity. If allowed to stand, healthy pus divides into two strata ; the upper, named *liquor puris,* is a clear liquid, almost identical with the fluid portion of the blood ; in fact, it is mainly the latter exuded through the walls of the vessels. The lower layer, which is faint yellow, contains little else than corpuscular elements. On microscopical examination the cells, which average $\frac{1}{2500}$ of an inch in diameter, are found to be of two kinds, the minority being exactly like white blood corpuscles, for they are possessed of amœboid movements, have no limiting membrane, and contain only one or two nuclei. The greater number, however, are more coarsely granular, and have two or more nuclei, which are only visible after the addition of re-agents. Acetic acid brings them into prominent relief by dissolving the albuminoid particles, and causing the protoplasm to swell up. Ether or liquor potassæ removes the fat granules. The multiplicity of the nuclei is generally considered as one sign of the death of the corpuscles, the original nucleus having broken up in consequence of degeneration. This opinion is supported by the fact that the secondary nuclei are smaller than the primary ones, and further, that the cells containing them are loaded with molecular fat. It is asserted by Cornil and Ranvier, however, that the primary nuclei undergo vital segmentation.

Pus is subject to various modifications, which are indicated by special names; thus, when it is mixed with blood it is said to be *sanious;* when more watery than usual it is called *ichorous.* The matter secreted by inflamed mucous membranes and some ulcers is often glairy from the presence of mucus (*muco-pus*). As it is readily decomposable it not seldom contains putrescent gases, and it may have a characteristic smell; thus the pus from an ischio-rectal abscess has a fæcal odour. Pus is known as *inspissated* when a great part of its water has been absorbed; and *caseous* when still further desiccated. The term *curdy pus* indicates that flakes of degenerated fibrin and cells are present in the fluid, and adherent to the walls of the abscess.

Pus from a chronic abscess is sometimes thin and watery, at others of firm consistence, the variation depending upon (1) the disintegrative changes in the solid constituents, and (2) the degree of absorption or effusion of serous fluid. In many instances very few corpuscles are present, but in their place are innumerable fat granules, and crystals of cholesterine and stearic acid. If the abscess is consecutive to bone caries there is an excess of phosphate of lime, and there may be minute osseous sequestra. The pus cells still remaining are very coarsely granular from advanced fatty degeneration. Some of them are greatly swollen; these are the so-called "compound inflammatory corpuscles" of Gluge; others are misshapen, and show evident signs of dissolution. The discharge from *gouty* abscesses is laden with needle-shaped crystals of urate of soda.

Pus from specific sores possesses contagious properties, and microscopical organisms are invariably present, but whether they constitute the virus of the disease in every case is a disputed point.

The pus from all acute abscesses contains micrococci. Pus exposed to the air is crowded with rod-shaped bacteria. Long bacillary filaments are met with occasionally in true infective inflammations. The contents of closed chronic abscesses are devoid of organisms. Very rarely the pus escaping from open wounds assumes a blue colour, which is given by a particular form of micrococcus, M. cyaneus.

Anatomy of an abscess.—To understand the anatomy of an abscess, it is necessary to bear in mind the salient features of the inflammatory process. We will take the simplest case, that of suppuration in connective tissue. During the progress of the inflammation the blood-vessels become dilated, so that the hyperæmia of the part is very manifest. Subsequent to the dilatation there is copious exudation of plasma, to such an extent, in fact, that the lymphatics are no longer able to carry off the excess of fluid. In quick succession the white blood corpuscles traverse the walls of the vessels, and accumulate in the interstices of the tissues. Many of them enter the lymph paths, and hinder still further the escape of serum. At this stage resolution is a possible event, but by the continuance of the exudation and migration the extravascular pressure is increased to such a degree that the current of blood in the capillaries is brought to a standstill, and very soon coagulation ensues. Meanwhile the formed tissues have become softened, partly by maceration, partly by liquefactive degeneration, the consequence of impaired nutrition; they have in truth been subjected to acute starvation. The walls of the obstructed vessels are not exempt from the process of destruction. The result of this melting away of the tissues is the formation of an abscess cavity. Now it will readily be seen that the contents of the latter will consist of (1) exuded serum; (2) migrated leucocytes; (3) liquefied tissue and clot. By almost general consent it is held that the connective tissue corpuscles remain passive throughout.

If the part in view of abscess formation be examined with the microscope, it will be seen that instead of the white blood cells being evenly dispersed, they are collected into groups, an appearance which led Virchow to assume that they were derived from segmentation of the fixed tissue cells. These groups of leucocytes are the centres of pus formation, so that an abscess visible to the naked eye is owing to the coalescence of many microscopical ones.

The wall of the abscess consists of hyperæmic granulation tissue, the so-called *pyogenic membrane*, but it contains no vessels of new formation.

The abscess continues to enlarge by progressive destruction of its wall, rather than by purulent secretion, such as is observed in a healing wound. After a time it tends to *point*, for, fluid pressure being equal in all directions, the matter advances most in the path of least resistance. Other considerations apart, this is a sufficient reason why deep-seated acute abscesses should be opened as soon as they are detected, for if left alone they may burrow into inaccessible and dangerous regions; this is especially the case with subfascial abscesses of the neck.

The eontents of *chronic abscesses* have been deseribed. With regard to their walls, mueh depends upon whether the formation of pus has eeased or not. In the former event the inflammatory neoplasia slowly organises into fibrous tissue, whieh, as it undergoes eieatricial eontraetion, obliterates many of the blood-vessels. This is one eause of the difficulty with which the eavities of ehronie abseesses are obliterated, the defeetive vascularity being unfavourable to the development of healthy granulations. Another is the rigidity of the wall of the abseess, whieh prevents its eollapsing when opened, whilst it renders easy the ingress of air, a fertile source of septie deeomposition.

Circumstances influencing suppuration may be divided into *local* and *constitutional.* It need searcely be said that so long as the essential cause of the suppuration eontinues to aet, so long will the proeess eontinue. The *local* conditions favourable to suppuration are (1) tension, (2) septie deeomposition of the inflammatory produets, (3) extensive meehanieal or chemical stimulation of the affected tissues. The influenee of *tension* is well exemplified in eases of suppuration beneath resisting structures, *e.g.* the periosteum, faseiæ, sheaths of tendons, ete. Take aeute periostitis of the tibia; an early and free ineision will not only eut short the mischief whieh is going on, but will probably prevent neerosis of the bone. In theeal whitlow, again, the fate of the tendon depends almost entirely upon the eontinuation or removal of the pressure of the imprisoned pus.

It has been truly remarked that the greatest triumph of modern surgery has been the establishment of the antiseptic treatment of wounds on a seientifie basis, inelnding, as it does, the praetiee of free drainage. The danger attending inoeulation of a wound with septic, or still more with infeetive, matter ean seareely be overrated. In eaeh there is the certainty of increasing the local inflammation, whilst in the latter there is the probability of starting fresh centres of suppuration in distant parts.

With respect to the *constitutional* states predisposing to or exciting suppuration, it should be noted that they act in a two-fold manner; (1) by causing primary disturbance in the nutrition of the tissues; (2) by undermining the patient's strength so that he is less able to recover from the effects of existing disease. To this it may be added that the products of suppurative inflammation of constitutional origin may in turn be the cause of further lesion, local and general. Lastly, the shorter-lived the general disease the more likely is it to induce acute suppuration, and *vice versa;* take, for example, small-pox, and tuberculosis or syphilis.

Absorption of pus.—It was formerly believed that pus in its entirety frequently found its way in large quantity into the general circulation, but we now know that the grounds for this belief were not well founded. In the first place, the older pathologists mistook decolorised venous clots for collections of pus; and secondly, the aggregation of leucocytes in inflamed vessels as evidence of purulent absorption. It is possible that pus may be driven into veins which have burst into the cavity of an abscess, but then, as Billroth has pointed out, it cannot happen to any great extent, for thrombosis quickly supervenes on the hæmorrhage. In the present day we understand absorption of pus to mean the passage of fluid and cells into the vessels much in the same way as they exuded from them, *i.e.* by osmosis and migration through their walls. The chief cause of the absorption is the extravascular pressure, hence the necessity for efficient drainage of suppurating cavities, and the inexpediency of applying a rubber band to limbs about to be amputated for diffuse inflammations. The peril lies not so much in the absorption of uncontaminated pus, but of septic and infective material with which the pus may be charged; and yet it is certain that the products of simple suppuration are capable of producing general pyrexia.

Varieties of abscess.—Abscesses are classified on several bases, which means that many of them will fall under more than one denomination, *e.g.* a "spinal abscess" is generally of "scrofulous" origin, and as it is slow in developing it is also termed "chronic." The chief division, however, and one of practical value, is into *acute* and *chronic*; not that it is always possible to say with precision into which category a given case should be placed; thus, as a rule, so-called strumous (scrofulous, tubercular) abscesses are chronic, but occasionally they form with such rapidity that they are appropriately designated "acute" or "subacute." The majority of acute abscesses arise either from a local cause or from some general disease, sudden in its incidence and rapid in its course; take, for example, a compound fracture; and infective osteomyelitis.

Then, too, abscesses are sometimes named according to their regional anatomy; for instance, we speak of "spinal," "mammary," "ischio-rectal," and so forth. Lastly, some marked feature in their general pathology may be indicated; thus we have "pyæmic," "gouty," and "tubercular" abscesses.

Cold abscesses are necessarily chronic in their course, and the inflammatory changes which give rise to them are so inactive that frequently neither the general nor local temperature is raised above the normal. It is not uncommon to find enormous collections of pus without there being any discolouring of the skin over them, unless perchance the superficial veins are dilated by the pressure beneath. The circulation is sluggish, for instead of active hyperæmia there is passive congestion, and on this account cold abscesses are otherwise known as "*congestive.*"

They are usually quite painless, and for this reason they often attain to large dimensions before they are recognised by the patient. When dependent upon disease of some specialised tissue like bone, they are termed "*consecutive.*" When deeply seated it is not rare to find them extending far beyond their place of origin, and as they travel downwards (in the path of least resistance) they are said to "*gravitate.*" A psoas abscess from caries of the vertebræ may be cited as an example. Whilst closed they cause little or no constitutional disturbance. They may remain quiescent for months or years. Occasionally their contents dry up, leaving nothing but caseous débris, which sometimes calcifies. But although the inflammation may have completely subsided, the affected tissue remains in a state of impaired vitality; it has become a *locus resistentiæ minoris*, which at some distant date may become the seat of renewed suppuration; the result is a *residual abscess.*

Tubercular abscess.—Opinions are divided as to whether the abscesses formed in connection with caries and "strumous arthritis" are of tubercular nature (the words "scrofulous" and "tubercular" are intended by the writer to convey the same meaning), but the balance of evidence seems to point to the conclusion that they are, for the *bacillus* of tubercle has been found in the inflammatory products in each case. Whatever may be the exact pathology of the diseases in question, their clinical features are well marked. Phthisis is a common antecedent and sequel. The most prominent characters of tubercular abscesses are chronicity, caseation, and prolonged discharge. They are found in many situations, but their favourite localities are the bones, the lymphatic glands, and the lungs.

Symptoms of abscess.—*Acute abscess.* In a part that has been acutely inflamed there are certain signs which point to suppuration. The pain becomes more throbbing; this is explained by the fact that the hypersensitive nerves readily receive the impressions made by the pulsation of the arteries, which, on account of the softening, are allowed greater latitude for expansion. It is an important symptom where the abscess lies deeply, *e.g.* beneath a dense fascia, for in this case it may be difficult or impossible to detect fluctuation. As the inflamed tissue melts away the hardness gives place to bogginess, and a little later to elastic tension, a sign of the presence of fluid. As the pus makes its way to the surface the superjacent skin is put on the stretch, which causes it to assume a shining aspect. At the same time it is highly congested. Then a pale spot appears in the centre of the swelling, showing cessation of the circulation and death of the tissue: the abscess is said to have "come to a head." Soon after it bursts. When the abscess is situated in regions where it is not easy to employ bimanual examination, *e.g.* in the tongue, prostate, and wall of the rectum, the surgeon will be guided to a correct estimate of the state of affairs by passing his finger firmly over the swelling; in the event of suppuration, it will be found that near the centre there is a somewhat sudden diminution in the resistance.

The constitutional symptoms vary greatly in different cases, according to the nature, size, and locality of the abscess, and the temperament of the patient; but speaking generally there is sharp pyrexia, the evening temperature being from 101° Fahr. to 103° Fahr., or even higher. The morning remission is not more than one degree. The commencement of suppuration may be accompanied by a chill or a distinct rigor, and in severe cases there may be a succession of chills, but then the fever curves are not nearly so steep as in pyæmia. The skin is hot and dry, the tongue parched and coated, and the bowels confined. There is more or less anorexia. Such are the general manifestations of an acute inflammation ending in abscess. As soon as the abscess bursts or is opened there is a rapid subsidence of the symptoms; the temperature quickly falls, and keeps low, if free escape is provided for the discharge, and septic and infective agents are excluded. The walls of the abscess collapse, so that the cavity is greatly reduced in size. For a time pus continues to be secreted by the granulations. The latter eventually organise into connective tissue. This is the end of the regenerative process. If an acute abscess forms in a tissue or organ where physiological and surgical rest are impossible of attainment, the local and general distress are intensified. Take *e.g.* parenchymatous suppuration of the tonsil. The symptoms attending a chronic abscess are, as before noted, conspicuously slight. Unless the pus be confined within unyielding walls there may be absolutely no pain.

Treatment of an acute abscess.—When once the matter is detected, the sooner it is let out the better. In the case of nervous patients who dread the knife, if the abscess be small and superficial it may be left to burst; if large and superficial it is a good plan to evacuate the pus by making a small aperture with a stick of potassa fusa.

Deep-seated abscesses are best treated by Hilton's method, as it gives full security against the danger of wounding large vessels and other important structures which are frequently displaced by the swelling. Make an incision down to the deep fascia, and pass a director cautiously through it and the infiltrated tissues until the pus is reached; then introduce a pair of dressing forceps, and, having opened the blades, withdraw the instrument. Insert a drainage tube, and apply an antiseptic dressing.

In central abscesses of bone it is advisable to penetrate them with a small-crowned trephine. When practicable, incisions for opening abscesses should be made in such a direction that the cavities can be freely drained, and the resulting scars be hidden as much as possible. When suppuration appears inevitable, the process should be hastened by the aid of poultices.

Treatment of a chronic abscess.—It may be laid down as a general rule that the longer a chronic abscess remains closed the better for the patient; but there are occasions when it is expedient to open them, *e.g.* when the skin is deeply congested and threatened with ulceration in several places; or where the abscess has assumed large proportion and still shows signs of spreading; or, lastly, where some important structure is involved. The process of drying up of chronic abscesses, not a very rare event, may be aided by drawing off the pus with an aspirator; this should be repeated several times before resorting to free incision. Considering the liability of septic decomposition and absorption, chronic abscesses, when opened, should be thoroughly drained and protected; and, when consecutive, an attempt should be made to remove the primary disease.

Tubercular abscesses contain caseous infective material, which may indefinitely prolong the morbid process even after the abscesses have been opened. For this reason the surgeon should endeavour to get rid of the offending matter, and set up healthy, reparative action.

SINUS AND FISTULA.

The terms *sinus* and *fistula* are often used synonymously in clinical practice; but, strictly speaking, a sinus has only one opening, whilst a fistula has two. When one extremity of a fistula ends in a *cul-de-sac*, the passage is said to be blind.

Varieties of fistula.—In a few cases fistulæ are of developmental origin, the most notable being those met with in the neck as the result of incomplete closure of a branchial cleft. But the large majority are the abiding remains of an accident, operation, or some pathological process.

During protracted labour the fœtal head may press upon the bladder or urethra, and with such force that a portion of tissue is deprived of its vitality, and consequently it sloughs away, and in this manner a communication is established with the vagina; *vesico-vaginal* and *urethro-vaginal fistula.*

In the operation for removal of a parotid tumour one or more of the ducts of the gland may be laid open, and eventually they may be cut off from their connection with the mouth by means of cicatricial contraction in the deeper part of the wound. It is characteristic of this condition that the fluid which escapes from the fistula is increased by the ingestion of food, and that it consists partly of *salivary secretion.*

The pressure of a biliary calculus sometimes causes inflammatory adhesion of the gall bladder to the intestine and perforation of the coats of both; *intestino-biliary fistula.* Or an abscess may form in the walls of the abdomen and burrow for some distance, and then discharge pus and gall stones on the surface. I have seen the orifice of a biliary *fistula* situated over the external abdominal ring.

Artificial anus is another instance of a fistula joining a mucous and a cutaneous surface. It may be the consequence of an operation (*e.g.* colotomy), of gangrene of the bowel from strangulation of a hernia, or of perforation of the gut by an abscess or injury.

Recto-vesical fistula may arise from the bursting of a pelvic abscess, and by cancerous or syphilitic ulceration eating its way from one viscus to the other, especially in the presence of rectal stricture, a condition which throws severe strain upon the diseased tissues. Lastly, the recto-vesical septum may be wounded during the operation of lithotomy.

Recto-vaginal fistula is usually the result of ulceration spreading through the partition between the two passages.

Perineal urinary fistula is generally caused by ulcerative perforation of the urethral wall behind a stricture. It may ensue upon the rupture of an extra-urethral abscess into the canal (Syme); upon the impaction of a calculus; and upon laceration inflicted from within by instrumentation, or from without by a blow or fall.

Fistula in ano is complete or incomplete, according as the track opens into the rectum only or on the skin only, or has orifices at both those points. The antecedents are ischio-rectal abscess and ulcer of the bowel.

Lachrymal fistula is a communication between the skin of the face and the lachrymal sac. It is in most cases the consequence of obstruction of the ductus ad nasum by inflammatory thickening.

Treatment of fistula.—The cause, if still existing, must be first removed. It would be useless to expect a perineal or lachrymal fistula to heal so long as the derivative passages remained contracted. In the next place, it is essential that all *muscular contraction* upon the parts be removed as far as possible. This is the treatment of fistula in ano, whether complete or blind: it is the rule to divide the sphincter. After operations for the cure of fistulæ implicating the pelvic viscera, *physiological rest* must be sought by relieving the parts from strain. Thus the bowels, having been freely opened beforehand, should be kept confined for some days, and the bladder should not be allowed to become distended with urine. A fistula which fails to close after the above requirements have been satisfied, must either be stimulated to increased activity by the application of caustics to the lining wall, or by some plastic operation.

In the **treatment of a sinus** the same principles are involved as in the cure of a fistula proper. Any causative disease, *e.g.* of bone, must be eradicated. Sinuses in the groin following suppurating buboes should, as a rule, be laid freely open, and the wound allowed to heal by granulation. If left to themselves, they may ulcerate into the large vessels and cause dangerous, or even fatal, hæmorrhage. If the track is a simple one, and the patient cannot conveniently lie up, it may be compressed by means of a light truss. In the same way in sinuses beneath the scalp, where free incisions are inexpedient, the movement of the occipito-frontalis muscle may be controlled by broad strips of plaister and a bandage.

V. ULCERS.

C. Mansell Moullin.

An **ulcer** is the sore or wound left after the loss by decay or destruction of some superficial part of the body, whether skin or mucous membrane. It may begin in the substance of the tissues deep down and work its way out; or, as in the case of aphthous, catarrhal, or eczematous ulcers, it may start from the surface. The process is essentially the same, but the name of ulcer is not generally applied unless the whole epithelial layer has been detached and the subepithelial tissue exposed.

When the nutrition of a superficial part of the body is much impaired, it either sloughs *en masse* or undergoes molecular disintegration, leaving behind it a sore which is called an ulcer. Injury alone may do this, the vitality of the part being so completely destroyed that it sloughs and leaves an ulcer. So will inflammation, whether it follows an injury or is excited by some specific cause; the tissues may be killed at once by its severity, but much more frequently it leads to molecular death only, so that they melt away in fragments, leaving a sore behind. This happens all the more readily if the circulation through the part has been interfered with by other causes, so that its power of resistance is not what it ought to be; and new growths such as rodent ulcer and epithelioma undergo degeneration and leave ulcers, or, as in the case of lupus and syphilis, are assisted to the same end by inflammation.

Ulceration consequently is the result of the decay of a part near the surface of the body, and may be caused by injury, by the development of new growths, or by inflammation, however produced. Any one of these by itself is sufficient, but much more often two or three combine together, and their power is all the greater when the nutrition of the part on which they act has been impaired in any way by other causes.

Causes.—Roughly speaking, there are *exciting* and *predisposing* agencies, although the distinction is not absolute. The former are sometimes so intense as not to require any assistance, and the latter, as, for example, in old age or in limbs affected by infantile paralysis, may almost suffice of themselves; a scratch in circumstances such as these producing an effect such as would not follow a serious injury in healthy tissues.

Among *exciting causes* are included injuries of all kinds, wounds, pressure, friction, heat or cold, chemical irritants and specific poisons, such as those of syphilis, typhoid, or diphtheria. Of these, some destroy the life of the part at once; others only by the inflammation they excite, which may or may not end in ulceration, according to its degree and the circumstances under which it acts.

The *predisposing causes* are either local or general. Some are inherited and others acquired. Scrofula, gout, scurvy, anæmia, syphilis in its later stages, disease of the kidneys, and old age owe their influence to the way in which they impair the general nutrition. The tissues are too delicate to resist, or they are unnaturally prone to inflammation and decay, so that ulcers which are often characteristic of the disorder develop much more easily than they should. Or the circulation fails from fatty degeneration of the heart, valvular disease, general obesity, venous engorgement consequent on bronchitis, and emphysema or other reasons. As a result, congestion and œdema set in, and of course, owing to the influence of gravity, they are most marked in the lower extremities. The skin and subcutaneous tissue become swollen and sodden with serum, and the slightest irritation suffices to excite an eczema which rapidly runs on to ulceration.

Other causes are *purely local.* Arterial obstruction from atheroma, embolism, or ligature, especially if there is any impediment to the collateral blood supply; cold, ergotism, or infantile paralysis involving a limb; varicose veins, thrombosis, phlegmasia alba dolens, obstruction to lymphatics from old lymphangitis or deep cellulitis such as often occurs after compound fractures; gravity, especially when there is long-continued standing; the pressure of tumours in the abdomen, repeated pregnancies; every single thing, in fact, that tends either to check the flow of blood towards a part or to prevent its return, that interferes with the arteries, capillaries, or veins, must be regarded as a local predisposing cause. The more feeble the circulation, and the greater the amount of œdema, the slighter the injury required to commence the process, and the more persistent and grave it becomes.

The process of ulceration is much the same, whether it starts from the surface or deeper down. When the subcutaneous or submucous cellular tissue is inflamed it swells up and becomes œdematous, partly from the increased amount of blood flowing through it, partly from the exudation of leucocytes and plasma into its substance. At the same time, the fibres soften and yield, and the intercellular substance melts away. If the skin over this dies or gives way, there is left an excavation, the walls and sides of which are built up of softened tissues infiltrated everywhere with leucocytes; and either cleanly cut, if the slough has come away in one piece, or ragged and irregular with shreds of fibrous tissue, yellowish or greyish in colour, not yet separated off, studding its surface. If when this has happened there is nothing further to interfere with the healing process, the number of leucocytes rapidly increases until they constitute nearly the whole of the surface; the superficial vessels lying in the softened and semiliquid tissues yield before the continual pressure of the blood in their interior, and stretch longer and longer in the direction of least resistance (that is to say, outwards), until in a day or two they form little tiny loops, which project upon the surface covered with a cap of leucocytes. In this way the base and sides of the ulcer become covered with minute papillæ (granulations) characteristic of the healing process where there is nothing to interrupt.

It is essentially the same when it commences from the surface. If the epidermis is anywhere rubbed off the vessels dilate and an exudation is poured out that softens and loosens the tissues and epidermic cells until the latter are carried away. Then the swollen and distended papillæ are exposed, covered on the top only by leucocytes and freshly formed epidermis, and give rise at length to granulations that cannot be distinguished from those already described.

Ulcers present certain varieties, which are well marked in proportion to the specific nature of the cause that has excited them; some (*e.g.* the primary syphilitic sore and rodent ulcer) being absolutely characteristic; others, as in the case of lupoid and scrofulous ulceration, shading off, as it were, into the commoner forms; and they exist under different conditions, *e.g.* healing, stationary, and spreading, which are sometimes, though wrongly, described as varieties, owing to the constancy of their character and the frequency of their occurrence.

1. **The healing ulcer.**—During the healing stage all ulcers present the same appearance; the cause does not signify; if it was specific, its action

must have come to an end for the ulcer to be healing. The surface is smooth and even; if depressed it shelves down gradually from the surrounding skin. It is covered over with bright-red, small, uniform granulations, neither painful nor tender, and not inclined to bleed when touched. The discharge is small in quantity, and consists of healthy laudable pus. The margin is soft and pliable, with a well-marked band between the granulations and the skin where the new cuticle is forming. This band, which is of a peculiar bluish tint, from the red blood-vessels seen through the thin layer of opaque cells, never appears except in close contact with already existing living epidermic cells. If it should start from any other point it is either because some epidermic cells have been detached from their natural site and fallen on healthy granulations (as in skin grafting), or because some of those more deeply placed (as in hair follicles) have been left behind, the whole thickness of the skin not being destroyed. Only the thinnest, last formed part has this peculiar tint: as it becomes thicker and older the blood-vessels underneath are obliterated by the progressive contraction of the deeper strata of cells, and the colour gradually fades, until in an old cicatrix there is a peculiar dead-white tint, shaded sometimes here and there with patches of pigment derived from the hæmoglobin of old extravasations.

The skin around is soft and flexible, able to move freely on the subjacent tissues, otherwise the base of the sore cannot contract. This power of shrinking at the base, which is due to the organisation of the deeper lying strata of cells, is essential to the healing process. If the skin is fixed down, or if the size is so great that contraction is impossible, cicatrisation either never takes place at all, or is very much delayed. The scar of a circular ulcer surrounded by healthy skin is seldom half the diameter of the original sore, measured as soon as healing is complete, so that the contraction is at least four times more efficient in bringing this about than the formation of the new cuticle round the margin.

2. **The spreading ulcer.**—An ulcer that is increasing in size presents an appearance in nearly every respect the reverse of this. According to the rapidity of its progress it is said to be *spreading*, *inflamed*, *phagedænic*, or *sloughing*. There are no granulations; the base is covered with shreds of sloughing tissue of all sizes, hanging on by the fibrous septa that resist the longest. The colour varies from ashy-grey to a dirty yellow, unless, as is very commonly the case, there have been small hæmorrhages on or beneath the surface. It is no longer uniform and level, but, according to the rapidity of the progress and the size of the sloughs, is eaten out and excavated in the most irregular manner. So also with the margin; if the ulcer is merely slightly inflamed, this is thickened and rendered firm by the exudation, and the edge of the sore is sharp and cleanly cut; or there may be sloughs of all sizes. When it is spreading rapidly, the edge and base melting away in minute fragments, so that without there being any large sloughs its size increases visibly from day to day, it is said to be phagedænic. This seldom occurs except in connection with syphilis, or as the result of exposure acting on a broken-down constitution. The more severe sloughing form, where extensive tracts in the neighbourhood suddenly become gangrenous, is almost confined to such affections as hospital gangrene.

The discharge from a spreading ulcer is always greater in amount than when it is healing; often it is offensive, or irritating to the skin round, loaded with débris of broken-down tissue floating in a thin semipurulent fluid, or stained with blood. The tissues round a sore in this condition are swollen, reddened, and hot, the seat of a burning throbbing pain, and often covered with a number of small vesicles or acute eczematous ulcers.

Sometimes in senile ulcers, or those which are slowly getting larger, small spots of gangrene make their appearance on the base or round the margin, due to sloughing of the granulations. This is most commonly met with after prolonged exposure to cold or wet in chronic ulcers of the leg, where the nutrition has for a long time been carried on with difficulty, and leads to the sloughing appearance so common in ulcers of this character during the winter months.

3. **The chronic ulcer.**—The most typical chronic ulcers are those met with on the lower extremity in persons who are past the prime of life, and who are compelled to stand for a long time every day. The favourite situation is just above the ankle, on the inner side of the limb. Here, from many causes, poverty of blood, disease of important organs, gravity, obesity, obstruction to veins and lymphatics, ulcers are more common than anywhere else; and owing to the persistent nature of the causes and the peculiarity of the local conditions, the scantiness of the subcutaneous tissue, and the readiness with which the base becomes adherent, are kept in a chronic, almost permanent, condition, sometimes healing a little, and again, when circumstances are unfavourable, breaking out once more as bad as ever.

The size, shape, appearance, character of the edge and base, present the greatest variety. They may extend completely round the limb; but unless there is some specific cause, such as syphilis, they seldom reach above or below the limit mentioned. The base may be pale, smooth, glistening and painless, or it may be irregular, with deep cavities exposing the muscles and tendons beneath.

They are called *exuberant*, or *fungous*, when covered over with large irregularly sized granu lations, that bleed at the least touch, such as form commonly after extensive burns; and *weak* or *œdema tous* when they are large, pale, and flabby. True granulations, small, uniform in size, and bright in colour, are never to be seen, though here and there, if the surface is smooth, small vascular elevations ready to become such may be detected.

In the same way the edge never shows the smooth, even, shelving level leading from the surface of the granulations to the true skin around. The margin of the latter may be concealed completely, in the fungous form, by the overhanging granulations which project above it; or it may be steep and sharply cut, with an edge as well defined as if the ulcer were inflamed. This is due in general to the state of the tissues around, which are thickened and hardened so as to be almost solid from chronic congestion and œdema. In the *callous* form this change has gone farther still, for here the edges are raised and rounded, firmly adherent to the tissues beneath, and covered over with a thick layer of whitened sodden epidermis.

The character of the skin around a chronic ulcer gives rise to still further subdivisions. It may be congested, swollen, as if it were inflamed, dusky red in colour, and deeply stained with pigment deposits of long standing (the congested ulcer).

Or it may be eczematous, with numerous minute and superficial ulcers surrounding a larger one, which has commenced in the same way. These are, for the most part, shallow, and associated with varicose veins, though this is only one of many causes, all of which tend towards the same end (the eczematous ulcer).

The history of a *congested ulcer* usually is, that on the inner side of the leg a small reddened patch makes its appearance in the skin, not affecting the surface; this becomes larger and larger, and, as it spreads, the colour in the centre becomes more dusky from old blood staining mixed with recent congestion. After this the skin and subcutaneous tissue alter their texture; the former becomes dry and scaly, the latter shrinks, becomes tough and hard, no longer flexible or accommodating itself to the movements of the tissues lying beneath, but firmly adherent and bound down. When this stage is reached, if a scratch detaches a small portion of the epidermis (and even at times this is not required), the skin, being badly nourished from the prolonged congestion, decays, and leaves a chronic ulcer, often circular, deeply cut, and surrounded by hard unyielding tissues.

The true *eczematous ulcer* is, as a rule, the consequence of an attack of eczema in a leg that is œdematous from any cause. Under these circumstances the blood-vessels and lymphatics are distended with fluid, and all the intercellular spaces, even in the papillæ and between the epithelial cells, loaded with an accumulation of serum. If, then, an attack of eczema breaks out, vesicles form readily on the surface, lifting up the firmer layers of epithelial cells, and exposing, when they break, the softened tips of the enlarged papillæ, covered still by a stratum of cells that have not yet been able to undergo the normal keratin change. These rapidly melt away, owing to the large amount of fluid discharged, and the swollen, tender, and congested papillæ are irritated and inflamed so that they spring up in the form of granulations. All stages of this process may be seen at once; often there are several small eczematous ulcers close together, all superficial, and covered with coarse, congested granulations; round them are numerous vesicles, discharging a slightly tinged fluid that stiffens on linen as it dries, and resting on a reddened, scaly, tender, and congested skin. Farther away the changes are less and less marked, until the region of unaffected skin is reached. Properly speaking, so long as it is superficial and surrounded by skin in a state of acute eczema, this should be regarded as a variety of eczema rather than as a special or peculiar form of ulcer of the skin. When deep it merits the term ulcer.

As a rule, chronic ulcers are devoid of severe pain. There is often, especially after long standing, a dull, aching sensation, owing to the tension to which the tissues are subjected, but unless a nerve filament is exposed on the surface or involved in some way in the margin, acute pain is generally absent.

4. **The croupous ulcer.**—Sometimes ulcers, no matter what their origin may have been, assume a croupous, and even a diphtheritic condition. In the former a firm yellow coating forms on the granulations, from which it may be easily peeled off without any serious result. It seems as if, from causes at present unknown, the discharge, that is in general thrown off as pus, coagulates and forms a dense rind of fibrillated material, mixed with fungous spores, which may be renewed from day to day. In the latter the appearance is the same; but, in addition, there is severe local inflammation, with high fever, and even typhoid symptoms.

5. **The scorbutic ulcer.**—Another ulcer, known *often* as the hæmorrhagic, has been described in connection with scurvy. The surface of the ulcer is covered with clots, owing to the state of the blood, and the granulations, when they are present, bleed with the greatest ease.

6. **The epitheliomatous ulcer.**—Malignant

disease gives rise to several different forms of ulcer which are quite definite, and derive their importance from the nature of the growth that encloses them. Epitheliomatous ulcers rarely occur under forty years of age, and become after that period each year more and more common. Their ordinary situation is at the junction of the skin and mucous membrane, or on cicatrices, and where parts have been for a long time subjected to irritation.

The base is hard, nodular, and irregular, often covered with sloughs and a foul purulent discharge; the edges are just the same, hardened and everted by the growth around them, which spreads into the tissues in the neighbourhood and binds the sore firmly down. The rapidity of the growth varies much, according to the situation, and so does the enlargement of the neighbouring lymphatic glands; but it is always an affair in which months make a distinct difference. No matter how careless they may be, patients rarely allow three months to pass before they seek advice. The amount of pain varies in different cases; exceptionally it is altogether absent; more often it is constant, increasing tenfold when the sore is touched.

7. **The scirrhous ulcer.**—The type of scirrhous ulceration is seen on the breast in cases of atrophic hard carcinoma. The base is very deeply excavated, pale pink in colour, perfectly smooth and glazed, without any sign of granulations, and with little discharge. Under and round it is a mass of dense growth, rendering it perfectly immovable on the tissues below. The edges are raised, often overhanging from the ulceration eating them out, peculiarly hard, very steeply cut on the side of the ulcer, but shading off gradually into the skin outside, which is often puckered and wrinkled in a radiating fashion from the contraction that has taken place. These ulcers are naturally much more

common in women; rarely occur under forty, and may last without apparent change for five and even a greater number of years. They are always preceded by a deep-seated tumour, which slowly and gradually involves the skin lying over it.

8. **The fungating ulcer.**—Soft sarcomatous and carcinomatous growths may, moreover, give rise to fungating ulcers of the most frightful description. There may be an opening in the skin, through which protrudes a mass of malignant growth, mixed with granulation tissue, and yielding a discharge of pus and blood, breaking down at the slightest touch; or the skin itself may be involved in the growth, so that there is no cavity from which the fungus can sprout, merely a rapidly growing, protruding bleeding mass. These are unmistakable; when once the skin is broken and all pressure removed the pace at which they grow is amazing. They may follow any form of malignant disease, even epithelioma, if it is continually irritated by mild caustics, and of course depend for their age and their clinical significance on the nature of the growth that has given rise to them.

9. **The rodent ulcer.**—Another form of ulcer frequently confused with epithelioma is that known as rodent, distinguished clinically from the former in that it never involves lymphatic glands, or causes secondary deposits, or induces any cachexia. Like epithelioma, it is most common in elderly people, but its situation is almost confined to the head and face, and particularly to the neighbourhood of the eyelids. Its growth, too, is infinitely more slow; it takes years to make as much progress as epithelioma does in months. The base is smooth and glossy, with little or no discharge, and the edges, though they are hard from the new growth that infiltrates their tissue, are smooth, rounded, and "rolled over." Its first commencement is a small

hard tubercle, often seemingly a wart, which slowly increases in size, sometimes becomes very prominent, and then ulcerates; the growth does not extend deeply into the tissue until it has lasted a long time, so that the base remains freely movable, able to be pinched up, for a much longer period than in the case of epithelioma. Histologically it seems to belong to the same class of tumours, and not improbably is epithelioma of the sebaceous glands: clinically it is totally different, as after free removal, no matter how long it may have lasted, it never returns. Pain in connection with it is very rare.

10. **The lupoid ulcer.**—Lupoid ulceration is of a totally different character, even when it occurs on the face, which is the most common situation. It is, by far, most frequent in young people, and affects particularly the alæ nasi, at the junction of the skin and mucous membrane. It is preceded and surrounded, so long as it is spreading, by small tubercles; but these are exceedingly soft, and break down and ulcerate with the greatest readiness. Its growth varies much in rapidity, but it is always chronic, often spreading slowly at one part, healing at another, and then again breaking out fresh, as a soft red spot in the centre of the old cicatrix. The edges are sharp, irregular, and eroded, never hard; generally small characteristic tubercles are present in the neighbourhood. The depth of the base varies; it may be quite smooth and superficial, with pale flabby granulations, secreting a small amount of pus, which dries and forms scabs and crusts on the surface; or it is deeper and more irregular, when the new growth has eaten into the cartilages. As it spreads in one direction it cicatrises in another, which rodent and epithelioma never do, leaving a thin, red, and irregular scar, which often breaks down again.

This form of lupoid ulcer is most often associated with scrofula, but there are others of which this does not hold good. One is common on the hands, particularly of those who have much to do with post-mortem work, and is quite independent of age or diathesis. It commences generally as a wart-like growth, covered over with scales, under which a slow process of ulceration takes place, and gradually involves the adjacent tissues. There are no small, even-sized, pale or gelatinous tubercles, such as are met with in strumous lupus, but it closely resembles this in the way it infiltrates the tissues and spreads.

11. **The syphilitic ulcer.**—Syphilitic ulceration presents the greatest variety. Particularly in the tertiary stage, sores may appear on the face, which simulate very closely some of those already mentioned. They are, however, always much more rapid ; at the most, it is a question of weeks, more often of days. As a rule, they occur about middle life, though other ages are not exempt. The base is never bound down to the subjacent tissues, as it is in epithelioma, and the margin never presents that cartilaginous hardness which is the characteristic feature of this disease and of rodent. The edge may be sharply cut, especially if the ulcer is progressing rapidly, and even overhanging ; but it is always soft, never raised above the level of the skin round it, or everted. So long as syphilitic ulcers are in the spreading stage, that is, so long as they retain their specific character, the base and margin are either covered with slough, or are of an angry, dusky red tint, with a thin blood-stained discharge, mixed with broken-down débris. The skin round is reddened for a slight distance, and may, especially in those cases that simulate lupus closely, be thickened and congested for a considerable distance ; but there are never any small translucent lupus tubercles with healthy skin between. This alone, with the different character of the base,

would distinguish them, even if the rapidity of the process were not taken into consideration. Tertiary syphilitic ulceration will spread farther and wider in a week than lupus will in six months. The character of the cicatrix formed is quite as distinct. In lupus there is nearly always, at one point or another, some evidence of cicatrisation, of the formation of a thin, red, unstable scar; in tertiary syphilis, except in the serpiginous form, which is characteristic in other ways, this is never present. When the violence of the poison has been overcome, the ulcer heals, leaving more or less of a depression, occupied by a dead white cicatrix, with pigment patches here and there, wrinkling up like tissue paper when it is pinched laterally, and never breaking down.

There are certain parts of the body which are especially the seat of syphilitic ulceration. They are the scalp, the angles of the mouth, the alæ of the nose, the junction of the hairy part of the scalp with the neck and face. Serpiginous tubercular syphilitic eruptions are especially common in the last-named region; also over the sternum and round the knee joints. It has been said that every ulcer on the leg, above the middle, is syphilitic. But they may occur anywhere. The ulcers on the scalp are often associated with exposed bone. Those about the mouth are apt to leave peculiar linear scars.

There are two forms, distinguished by the locality and the amount of the syphilitic deposit. In the one there are large accumulations (gummata) in the subcutaneous tissue, which slough out and leave deep circular holes, with overhanging edges, of all sizes and in any number. In the other the deposit is in the substance of the skin, raising it up in the form of dusky red, scaly tubercles, arranged in circles, or parts of circles. Sometimes these subside without leaving ulcers; or they break down, and then a ring of superficial sores is left with a patch of reddened congested skin in the middle. These ulcers are peculiar in the way they spread, healing on the concave side and extending on the convex, so that often horse-shoe-shaped sores are formed, which creep, in this fashion, over a large surface of skin before they finally get well.

12. **The strumous ulcer.** — Scrofulous and strumous sores are most common in the neck, in the groin, over diseased glands, and over inflamed joints; but they may occur anywhere, particularly on the legs, in young and poorly nourished patients. They are very chronic, painless, and discharge only thin, oily pus. The base is pale and flabby, with coarse œdematous granulations, and the skin round is undermined for long distances, so that the edges overhang, with loose flaps of a blue or purple colour; sometimes distant sores are connected together in this way by long superficial sinuses running under the skin, lined with unhealthy granulations. When they do heal, the cicatrices are thick and irregular, with seams and bars running across them.

It must not be imagined that these forms of ulceration are always clearly distinguished from each other. A varicose ulcer of the leg, for example, may have had both an eczematous and syphilitic origin; and become chronic, as much from general malnutrition as from the impediment to the circulation, of which again varicose veins may be only one cause out of many. Local and constitutional causes in nearly all cases combine together, and the ulcer breaks out at the spot where the two can act with the greatest intensity.

The treatment of ulcers depends entirely on the cause. It may be local or constitutional; generally both together. In those that are caused by malignant growth the latter is of but slight service. Cancerous or rodent ulcers must be treated as carcinoma is.

Others, such as lupus and syphilis, require both; in the former the growth must be got rid of by scraping with a sharp spoon (which removes all the new tissue without injuring the old), and afterwards applying the actual cautery, or the acid nitrate of mercury. But the tendency to return must be stopped by good food, fresh (especially sea) air, tonics, and cod-liver oil.

In syphilitic ulcers the constitutional treatment, by iodide of potash in gradually increasing doses, with bichloride of mercury, if the patient has not already been subjected to a prolonged course, is even more important. The spreading of the ulcer is due to the diathesis, its outbreak at a particular spot to local conditions.

If it is phagedænic, iodoform at night, with continuous warm baths during the day, will nearly always stop it. When this cannot be carried out the surface of the sore must be destroyed.

Iodoform succeeds nearly as well in ordinary syphilitic sores, especially if the taint is dying out. The more recent the infection and the more characteristic the ulceration, the more successful is the use of mercury, locally, in the form of black wash or blue ointment.

Many cases of tubercular ulceration, which obstinately resist treatment, yield readily when, in addition, subcutaneous injections of pilocarpin are made use of.

In scrofulous and strumous ulcers the constitutional treatment is even more important. They are often benefited by having all the unhealthy granulation tissue scraped out, the overlying bridges of skin cut off and pared down, and, especially if they occur in the flexures of joints, by being maintained in thorough rest; but unless constitutional treatment is combined with this, the cure will not be permanent.

Ulcers that are healing get on best when left to themselves as much as possible. The tendency to exuberance must be checked by astringents, changing often from one to another; they rarely require more. *Skin grafting* assists very much in those of large size. Small fragments are removed from healthy skin, either by means of a sharp pair of scissors, or by a proper pair of grafting forceps, and laid on the granulations near the healing edge. Each graft must include the growing stratum of epidermis, but need go no deeper. Within twenty-four hours it will be quite firm, and by the next day will have become the focus of fresh cicatrisation. This, however, only succeeds when the ulcer is already healing; if the granulations are not quite healthy, either the graft does not take at all, or in a short time, especially in the case of burns, the whole of the newly formed epidermis melts away again.

Rest, elevation of the limb, warmth or cold, according to the patient's wish, are the most effectual methods of checking the course of a spreading or an inflamed ulcer.

Deodorants and disinfectants may be made use of, but it is much more important to check the causes that have led to the sloughing. When this has ceased, the discharge will rapidly become healthy.

Irritable ulcers must be treated either by dividing the nerve that is exposed on the base, or by covering the surface with a protecting layer, such as that formed on the application of caustic. Under this it will generally heal as under a scab.

Chronic ulcers require a much greater variety of treatment, as the congestion and solid œdema, which help materially to originate them, generally depend on causes which it is impossible to prevent. In the most incurable the base cannot contract. Attempts have been made to remedy this by means of longitudinal incisions into the subcutaneous tissue on either side; by blistering, which, by the increased discharge it causes, helps to carry off some of the infiltrating material; and by careful and even strapping over the ulcer. This, especially if the discharge is slight, and the ulcer not eczematous, is one of the best. It causes absorption by its pressure, it prevents further congestion, and it tends to approximate the edges. The same result may be obtained, when the edges are thick and raised, by bandaging a thin piece of sheet lead directly over the sore. Here, in addition, the lead which is gradually eroded assists by the contraction it induces in the superficial vessels.

Martin's bandages, applied next to the skin during the day time, from the foot up, are the most excellent when there is no tendency to eczema. When this is the case a number of small eczematous ulcers form from the retained secretion, and often make matters worse.

Of all local remedies, elevation and rest are the most efficacious; but ulcers healed under these conditions rarely remain sound when the patient gets about again. It must never be forgotten that the congestion and œdema, which help to originate the process, and more than anything else make it persistent, are only in part of local origin; that visceral degeneration, obesity, general malnutrition, and many other causes, all add their quota, so that local remedies by themselves can rarely be successful.

When the sore completely surrounds the leg, or when the pain is continuous and unbearable from deep adhesions of the cicatrix, it sometimes happens that amputation is advisable, particularly if the patient is young and the blood-vessels not affected by atheroma.

VI. GANGRENE.

JOHN DUNCAN.

ULCERATION and gangrene are terms used to designate the process by which portions of the body die and are cast off. No hard and fast line can be drawn between them; but roughly it may be said that in the former death occurs by minute, in the latter by large and palpable quantities. *Mortification* may be taken as synonymous with gangrene. *Slough* and *sphacelus* are used to indicate the portion killed.

Gangrene arises either from direct destruction of texture, as in the action of heat, or from insufficiency of the blood supply, as in ligature of an artery. These causes may and do act separately, but frequently also in combination; and there are various forms of gangrene, such as the neurotic and inflammatory, in which it is difficult to say whether the result is chiefly due to diminished vitality of texture or to interference with the circulation of the blood.

I. It is impossible, then, to classify with etiological precision, but I think we may best get a clear idea of gangrene by considering first what occurs when a portion of the body is *destroyed by external agents*, which act directly upon the tissues. The chief of these are caustics, heat, and mechanical violence.

1. **Aseptic gangrene.**—When a part of the organism dies, nature at once makes an effort to separate it from that which remains alive. There is a precise analogy therein to the ordinary processes of nutrition, whereby matters which have become effete are removed. In the decadence of the deciduous teeth, the fang is absorbed, the crown is thrown off. If a piece of catgut be lodged in the tissues the

portion inside will dissolve away, that outside will fall off unchanged. So it is with any texture which has become gangrenous; a certain amount is absorbed, the remainder is thrown off. In the still living surroundings granulation tissue is formed, whose cells penetrate the dead and slowly eat it up. They penetrate as far as circumstances permit, and at that point the slough, ceasing to have connection with the body, drops off. The conditions which determine the amount of penetration are various, and, with one exception, apply equally to a slough on the surface of the body and to one which is subcutaneous. In both the health of the surrounding texture, the cardiac and nervous force, the nutritive value of the blood, and the amount of work which is thrown upon the absorbents, will determine the degree of absorption and the presence or absence of inflammation.

But on the surface of the body the slough becomes immediately subject to that decomposition which affects all dead organic matter, and which, it is now known, is due to the action of microbia. Now these microzymes are inimical, both in themselves and in their products, to the living tissues also, and are perpetually engaged with them in a struggle for existence. Whether, and how far, one or other may prevail, depends, first, on the virulence of the microbe; second, on the nature of the soil (has, for example, the part died with much moisture in it, or with little?); and third, on the germicide value of the living tissues (were they strong and healthy originally? has the injury diminished where it has not extinguished their vitality?) In any case the growth of granulations is restrained. Cells, which would naturally organise, are produced in excessive numbers, and are discharged as pus; and while little of the slough is absorbed, much is thrown off. An element of danger, inflammatory and septicæmic, is thus introduced into the gangrenous process, which we shall presently see at its worst in spreading gangrene, but which is apt to complicate every variety.

In the matter of *treatment* this element, sepsis, must never be lost sight of. Its importance may be shown by an illustration.

When a surgeon applies the actual cautery he lays his account with a prolonged suppuration during the separation of the slough. But if he will carefully render the surrounding skin aseptic before applying the iron, and afterwards cover the slough and a large margin with salicylic wool and flexile collodion, he will find that healing takes place without a drop of pus, and that the slough almost entirely disappears by absorption.

Should a limb or other portion of the body be killed or rendered non-viable, it is our duty to advise its immediate removal. We thus avoid the risk of the gangrene spreading, and make a better stump than nature can. But occasionally the patient obstinately refuses amputation. The surgeon should then endeavour to render the part aseptic, and if it be of moderate size, or if the breach of surface be small, he will frequently be successful, and may await the patient's time with equanimity.

But frequently, from lapse of time, or otherwise, the part which is gangrenous is also putrescent. If it be a limb, amputation is of course to be performed, but if that be not necessary or possible, every means must be taken to secure perfect drainage, and encourage external discharge.

I have pointed out that the occurrence of sepsis always modifies, by way of inflammation, the separation of a slough. But its action may be much more injurious. From the point of introduction there may spread a septic gangrene into the living tissues. We have examples in traumatic gangrene, hospital gangrene, noma, and cancrum oris.

2. **Traumatic gangrene.**—*Acute*, *spreading*, or *moist gangrene*, as it has been variously called, is prone to arise when a limb, or a portion of it, is by injury rendered incapable of continued life. Its death may be due to immediate destruction of texture, to disruption of arteries, veins, and nerves, to the pressure of bloody or inflammatory effusion, or very frequently to a combination of all these causes. What is essential for the production of spreading gangrene is that tissue thus killed be retained in close apposition with the living.

There appear, first, slight swelling and a certain dusky redness of the skin, marbled with bluish lines, from coagulation of blood in the superficial veins. This alteration in colour, although highly characteristic, is not strongly marked, and may be masked by precedent extravasation of blood into the parts above the site of injury, especially if injections of carbolic acid have been performed. It spreads by leaps and bounds, many inches, perhaps, in a few hours, and as it advances, is followed by the advent of bloody phlyctenæ, and by crepitation on pressure, from the presence in the subcutaneous cellular tissue of the gases of decomposition. If incisions be made, the vessels do not bleed, the tissues are pale and œdematous, and it is found that this exsanguine condition reaches higher in the loose cellular tissue than in the muscles or skin. Severe constitutional disturbance is concomitant. A high temperature, with intense depression, are its special characteristics, and in a very short time, numbered by days or even hours, the patient may succumb from asthenia. Failure of the heart, cerebral disturbance, with profuse perspiration, rapid respiration, and general defective action of all the vital functions, make themselves very manifest.

When we consider that this disease shows itself, if at all, within a very short time from the injury and before the living can be blocked off from the dead by granulations, that it is necessarily and invariably preceded by a breach of surface, that the probability of its occurrence corresponds to the freedom of drainage at the point where the living and the dead join (for the more complete the severance of the dead limb, the less probable is it), and that the line of most rapid extension is the loose cellular tissue, it is impossible to doubt that we have here to deal with a purely septic disease. The constitutional state is also typically septicæmic, of that variety which is due to the continuous absorption of poison from the part. Nor is this conclusion invalidated by the fact that other conditions such as alcoholism, which depress the vital energy, predispose to traumatic gangrene.

Under these circumstances there can be no hesitation as to the proper *treatment.* Nature is unequal to the arrest of the disease, and the moment spreading gangrene has declared itself, amputation is essential, and every hour is of importance. The success of the operation is not great, and depends on the ability to cut wide of the disease. But it is not hopeless, and the surgeon is bound to give his patient the chance.

3. **Phagedæna, sloughing phagedæna, hospital gangrene,** are terms which indicate the same disease under different degrees of severity or with a special causation.

Its tendency to endemic prevalence in over-crowded prisons, ships, and hospitals, its clinical study generally, and the results of inoculation, teach us that it is due to a specific morbid poison of organic character communicable to a wound by direct contact, and possibly through the air.

The improved hygiene of later days has practically banished this disease from civil life, at least in its more severe and assuredly in its endemic form. It has much mitigated its incidence even in military surgery. But formerly, as in the Hôtel Dieu of Paris, its frequency and mortality were such that a grave question arose as to whether the aggregation of the wounded in large hospitals was a greater curse or blessing to the community.

A breach of surface is an essential condition, but wounds may be attacked by it at any stage of their progress to healing.

In *simple phagedæna* there is rapid molecular death, with precedent dusky inflammation. The discharge, from being purulent, becomes scanty, serous, and loaded with débris; the granulations (it is usually a granulating wound which is attacked) become sloughy and sometimes covered with a diphtheritic-looking membrane. There is always constitutional disturbance, fever of the adynamic type, proportioned in intensity to the severity of the local disease.

In *hospital gangrene* the destructive processes are more rapid. It has been divided into the black and the grey form of phagedæna, from the colour of the slough. In a wound previously progressing favourably the surface or margins suddenly transform themselves into black or grey sloughs, the surrounding parts become œdematous, dusky red, and covered with phlyctenæ, while the discharge grows extremely fœtid, and is loaded with shreds of dead tissue. The constitutional symptoms are severe. Rigors, or chilliness, mark a rapid rise of temperature, and this is accompained by great depression of the vital powers, by a pulse weak, quick, and often irregular, by profuse perspiration, and frequently by a busy muttering delirium. Death may be extremely rapid, and is sometimes hastened by hæmorrhage from the sloughing sore.

Phagedæna may attack any region in the body, but is probably most prone to occur in the penis, and usually in association with the sores to which that organ is liable. Many years ago I was much impressed by a case in which a surgeon had simply divided the frænum for the better treatment of a chancre. In four days the whole integument and a portion of the substance of the organ sloughed, and the patient died from the blood poisoning which accompanied it.

There is a general opinion among those who have had experience of hospital gangrene, that it is an ochlotic disease, and it is probable that a vitiated atmosphere may render patients more prone to it and more likely to succumb under its influence. But it is certain that the conveyance of the materies morbi from wound to wound is chiefly due to actual contact, as through the fingers, clothes, and apparatus of the doctor, nurse, or dresser, and that absolute isolation and rigid antisepsis constitute the true prophylaxis.

The local *treatment* of the disease should be primarily by the free use of an escharotic to destroy the infective material. The actual cautery was at one time much in vogue, but powerful caustics are probably more effective. The application of chloride of zinc or nitric acid should be followed by antiseptic or deodorant poultices to receive discharge and aid its escape. If necessary to render the drainage perfect, incisions should be made, but ought always to be followed by the use of the escharotic.

No internal remedy is of value in checking the progress of the gangrene. Opium may be useful to allay pain, quinine and aconite as antipyretics, digitalis in cardiac failure ; but the constitutional state depends on the local, and our efforts should be directed simply to conserve the patient's strength and regulate the general functions until, the phagedæna being arrested, we may build up his strength again by nourishment, stimulants, and tonics.

4. **Noma** is a form of sloughing phagedæna dependent on a cause similar to that which produces hospital gangrene. This poison finds its congenial soil in badly-nourished children, and especially in those who are recovering from a zymotic or other acute disease. It attacks the female pudenda and the cheek, and in the latter locality has received the name of *cancrum oris* (Fig. 1).


Fig. 1.—Cancrum Oris.

It begins on the inner surface of the cheek opposite a bicuspid or molar tooth, where there is a natural tendency to abrasion. It frequently escapes notice until it shows itself as a dusky spot on the outer surface, which speedily becomes black, and, spreading with great rapidity, often opens into the mouth at its angle before it can be checked. Sometimes it begins on the gums and is confined to them.

On the pudenda noma usually begins at the junction of the skin and mucous membrane.

It is accompanied by fever and depression, and, like hospital gangrene, is very fatal.

When recovery takes place, the contraction of the cicatrix, particularly in cancrum oris, may cause great deformity, and seriously interfere with the movements of the jaw from adhesion of the cheek to the bone.

The treatment of noma is not unsuccessful if caught in the early stage or before blood poisoning has produced irrecoverable depression. I have seen it arrested both when it left a simple hole in the cheek and even after it had largely opened into the mouth. So soon as the sloughing ceases the temperature falls, and the patient is practically out of danger but for a certain tendency to fatal syncope during convalescence, which it shares with diphtheria and other diseases causing cardiac depression, but which may be guarded against by the enforcement of rigid recumbency. Careful nourishment and judicious stimulation are our most important means of constitutional treatment, while the free use of an escharotic such as nitric acid is indicated locally. What has been said of hospital gangrene applies also to noma.

II. We have considered gangrene from direct destruction of tissue. It may arise also from *modification of the nutritive blood supply*, by way either of quantity or quality.

1. **Constriction** of a part may cause diminution of its blood supply, and so lead to its death; and this may ensue even when the current is only partially arrested.

When the constriction is complete there are important distinctions between cases in which the member is full of blood and those in which the vessels are absolutely empty. In the latter the blood supply may be cut off for a longer time, because there can be no infiltration and no risk of permanent obstruction from coagulation. But how long a limb, whether empty or full of blood, may be kept constricted is by no means definitely determined. I have known an Esmarch's bandage and tourniquet kept on for five hours on account of aneurism without evil result, nay, even without cure of the aneurism.

If the constriction be only partial, as in the strangulation of a hernia or in tight bandaging, another element comes into play. The venous circulation is more easily obstructed than the arterial, and its obstruction is followed by exudation into the textures and great increase of pressure. I have met with a deplorable example of this form of gangrene. Having operated on a child for club foot, I some days afterwards sent it home with a plaster of Paris boot. It took severe chicken-pox shortly afterwards. Being at a distance in the country, the medical attendant saw it for the first time a week after it took ill, and found the foot completely gangrenous from the swelling caused by the pustules.

2. **Obliteration of the main artery** is a not uncommon cause of gangrene of a limb. It may be due to *ligature*, *embolism*, or *thrombosis*.

In ligature a definite and limited obstruction exists, but the effect may be modified in one direction by the additional obstruction of an aneurism, in the other by a previous enlargement of the collateral circulation. In embolism and thrombosis the extent to which the artery and its branches may be filled by coagulum is naturally a point of great importance, but not easy to determine. The extent, therefore, to which the gangrene may extend is very variable, and cannot be ascertained beforehand. In ligature of the femoral only one or two toes may perish, or mortification may extend up to or beyond the knee.

The gangrene spreads rapidly from the extremity to the point where the circulation is just sufficient for nutrition; the parts thereafter gradually pass from lividity to blackness, and become dry and shrivelled. Spreading gangrene does not supervene, because there is no breach of surface; but when the granulations form their "line of demarcation" between the dead and living, it may be that septic irritation is produced, and possibly some further extension of the slough.

In these cases there are often sources of constitutional disorder, cardiac or other, which aggravate, and are aggravated by, the gangrene, but with judicious treatment a large proportion ought to recover.

The moment obstruction of a vessel is recognised, and still more if impending mortification be visible, the skin should be rendered aseptic, and the whole wrapped up in antiseptic wool. For many weeks it should be left untouched, that the collateral circulation may have time to strengthen, and then amputation should be performed at or near the line of demarcation, to secure a better stump, and to save time in the division of the bone.

Since adopting this plan I have been greatly pleased with the complete absence of constitutional disturbance, and the satisfactory local result in all cases. Let me mention two.

A woman, æt. 41, was admitted to the Edinburgh Infirmary with gangrene of the hand, produced by obliteration of the brachial artery from the origin of the superior profunda to the bend of the elbow. She had rheumatic valvular disease of the heart. The treatment detailed above was adopted, and, after ten weeks, finding the collateral circulation good, I amputated at the wrist, where there was a deep line of demarcation, and, under salicylic dressing, secured healing absolutely by first intention.

A remarkable case was that of an old gentleman, aged 81, a patient of my friend, Dr. Foulis. Sudden obliteration of the left femoral artery, from the groin downwards, had led to gangrene of the leg as high as the knee. His arteries were extremely atheromatous, and for many weeks previously his cerebral circulation had been much disordered. I wrapped the limb carefully in salicylic wool, and for five months our patient lay free from pain, without constitutional disturbance, and with a gradually improving mental condition. I then amputated through the middle of the thigh, which had shrunk above the line of demarcation absolutely to skin and bone. A portion of the flap sloughed from defective nutrition. The patient died three months afterwards, not from the amputation, which had progressed very favourably, but from a severe attack of broncho-pneumonia.

3. This last case is doubtless closely allied to the next form of gangrene which has to be mentioned, **senile gangrene.**

Atheroma, frequent in old age, necessarily more or less impedes the circulation, by diminishing the elasticity and calibre of the arteries, and its effect is apt to be increased by a weak or diseased condition of the heart. Two varieties of senile gangrene are described as resulting therefrom, viz. the dry and the moist. The actual incidence of the gangrene is preceded by other signs of defective circulation, and sometimes by severe neuralgic pains.

In *dry* gangrene the disease is of a very chronic character. There is no inflammation and no fever, or very little. I have known six toes, or portions of toes, blacken, shrivel, and drop off at intervals without the knowledge of the patient, who was blind, and I possess an entire foot which was amputated by nature in this quiet way above the ankle.

But the process may be more rapid, provoked, perhaps, by some external cause. Some fluid remains in the textures, and when granulations form they are associated with dusky inflammation of the imperfectly nourished, but still living, textures. In this, the *moist* form, there is prone to be adynamic fever, and the slightest irritation provokes extension of the gangrene. The moisture, in short, provides suitable pabulum for bacteria.

In the *treatment* of senile gangrene we are often confronted with questions of the greatest difficulty. A nourishing, but not stimulating, diet is appropriate, and perfect rest should be enjoined. The local measures are such as I have described for gangrene after thrombosis, but the nature of the stump is not of importance, and much may be left to nature. If putrescence have been allowed an entrance, the best dressing is still the wool, with oiled silk interposed at the granulating points. No ineffective interference is permissible. I have seen the gangrene spread because the surgeon snipped a tendon.

Amputation is justifiable, however, if the patient be suffering constitutionally, provided it be performed where the circulation is sufficiently good, and with thorough antiseptic precautions.

4. Gangrene from cold or **frost bite** depends largely on circulatory obstruction, although the tissues themselves are doubtless also devitalised. A low temperature produces general, as well as local, depression, and in this country frost bite is rare, except in those who are predisposed by constitutional infirmity. The gangrene may be the immediate effect of the low temperature, or may follow inflammatory reaction.

In the matter of *treatment*, experience seems to point to a careful restoration of the vital powers, and locally to the use of friction with snow, or at least without warmth, although, theoretically, it is not easy to see why this local treatment should be preferable to absolute rest, enveloped in cotton wool. When the line of demarcation indicates the position for it, amputation should be performed, and is fairly successful. In a tramp, who had eaten nothing for twenty-four hours, and had slept in a barn with the thermometer at 22°, I found both legs absolutely gangrenous. Having swathed them in wool, and waited for demarcation, I amputated on both sides, with complete success.

5. **Bed-sores.**—A certain tension or pressure is essential to healthy nutrition. If it be diminished, growth increases; witness the inner condyle in genu valgum. If it be increased, atrophy, ulceration, or gangrene follow, according to its severity. This effect is chiefly due to pressure on the blood-vessels. Over prominent points of bone, in weakly people, sloughs are apt to form from recumbency in one position. In certain forms of paralysis, notably after fracture of the spine, the difficulty of preserving the skin unbroken is proverbial. This is partly due to the

anæsthesia and abrogation of voluntary movement, but chiefly to the paralysis of the blood-vessels, which renders them incapable of resisting the pressure applied.

Much may be done to prevent by water-beds, air-cushions, change of posture, stimulating lotions, and by covering with collodion or plaister. When the sores have formed, the simpler the dressing the better.

6. A curious form of gangrene from **ergotism** has been frequently observed in countries where rye is the staple article of food. It doubtless depends on the special action of the poison on the small vessels, but it chiefly occurs in those who have been subjected to much privation.

VII. GENERAL PRINCIPLES OF OPERATIVE SURGERY.

PROF. WILLIAM STOKES.

THERE are certain topics which the surgeon should ever bear in mind in seeking for guidance in his operative work. Among these may be mentioned :

1. The reciprocal action of wounds and certain constitutional affections.

2. The conditions of health most suitable for operation.

3. The treatment previous and subsequent to operation ; and

4. The immediate as well as remote dangers, and causes of death after operative interference.

1. **The reciprocal action of wounds and certain constitutional affections.**—M. Verneuil has classified the constitutional states that affect and are affected by wounds into three distinct groups :

a. Diseases of nutrition : cancer, scrofula, arthritism, scurvy.

b. Diseases resulting from the introduction *ab extra* of a poison : syphilis, alcoholism, malaria, hydrophobia, septicæmia.

c. Organic diseases of heart, lungs, kidneys, brain, and spinal cord, etc.

These act in a threefold manner in retarding or preventing repair : first, by predisposing to the occurrence of certain complications, such as hæmorrhage, inflammation, and neuralgic affections ; secondly, by retarding or destroying whatever repair may have already occurred ; and thirdly by the development of definite diseased conditions at the situation of the wound.

Among the conditions which, it is alleged, signally affect reparative action, old age has been mentioned. Assuming, however, that the patient is generally in good health, old age does not appear to be a factor that influences repair unfavourably. I could instance numerous cases of very aged persons on whom I have performed operations of great gravity, in which the wounds united as rapidly, firmly, and thoroughly as they do in persons in the early and middle periods of life. Prof. Humphry has recently drawn attention to this subject, and is of opinion that the repair of wounds and fractures and the healing of ulcers takes place as quickly in the aged as in middle life.

In the constitutional diseases above referred to, it must be noted that in one phase, that of dyscrasia, no special influence, favourable or unfavourable, on either the general condition of the patient or on the wound, is observed.

In another phase, where there are distinct local developments of constitutional disease (as, for example, in cases of mammary cancer, or scrofulous articular disease), the process of healing does not frequently run so smooth a course. Not only is the progress of the wound locally unsatisfactory, but, notably in cases of cancer, the operation appears to have the calamitous effect of rousing into activity the hitherto dormant energies of a fatal malady. In one other phase, namely, where there is evidence of disease of important organs, such as the lungs, liver, heart, kidneys, etc., the surgeon has even stronger grounds for grave apprehension as regards the reciprocal effects of the trauma and the disease.

The outcome of these remarks is, that any injurious reciprocal action between a trauma and a constitutional disease is less likely to be observed in the initial stages of such a malady than during any of its later developments, consequently wounds are more likely to run a smooth course and be unattended with any "surgical calamity," to use an expression of Sir J. Paget's, in the so-called dyscrasic period, before the appearance of any specific local disturbances, and *à fortiori* before there is evidence of any visceral lesion.

To discuss a little more in detail the reciprocal influences of certain special constitutional affections and traumatisms, attention may first be directed to **cancer.** I think it may be laid down that the mutual influences referred to depend largely on whether the manifestation of the disease is limited and localised, or not. If it is (as, for example, in a small scirrhus of the breast, or an epithelioma of the lip) without glandular complications, no unfavourable influence, one way or another, is, as a rule, observed. When, however, that stage of localisation has been passed, then it may often be noted that not only is the reparative action in the wound unsatisfactory, but also that the operation appears to stimulate the relatively dormant disease into a dangerous and fatal activity. This it is which makes surgeons of judgment and experience so slow in undertaking operations of the kind; and, when they do consent to "give the patient a chance," so cautious and grave in their prognosis.

In cases of **scrofulous disease** the development of phenomena analogous to those just discussed need not be dreaded; for although in these cases the reparative process often runs the reverse of a normal course (this is especially to be noted in cases of joint resections, in which not unfrequently fungous growths, abscesses, fistulæ, etc., appear in the vicinity of the wound and prevent its closure), this result, I believe, is mainly due to portions of diseased structure being left in the wound. As a proof that the existence of a strumous diathesis does not of itself materially militate against satisfactory wound repair, may be mentioned the fact that in such cases as have been just alluded to (viz. of joint resection in which union is interrupted), when an amputation at a distance from the local trouble is had recourse to, the healing of the wound pursues, as a rule, a perfectly normal course.

The way in which wounds at times act as immediate exciting causes of **erysipelas** is well known, and equally, if not more interesting, are the effects of erysipelas on wounds. Professor Zuelzer observes on this point: "On recent wounds, also, erysipelas often seems to exert an influence, although not always one favourable to their recovery; especially, according to Ritzmann, where small wounds still exist. In five of his cases, chiefly penetrating wounds, they were attacked by gangrene, which they recovered from, however, immediately after the termination of the erysipelas." He believes it possible to explain this peculiar influence, on the supposition that "old infiltrations may be more easily brought to softening and resorption by the uniform intense inflammation of the skin, and the altered relation of tension and hyperæmia in the affected parts."

The reciprocal effects of wounds and **nerve lesions** are also very remarkable. Professor Erb draws attention to wounds as etiological factors in inducing neuralgia of a most violent form. "In many instances," he observes, "this effect has been the result of injury done to some small and purely sensory branches, as, for example, in venesection, or in wounds of the nerves of the fingers." Sciatica, too, is an affection which in many instances has been known to result from wounds, falls, fractures, etc.; and among the causes of true paralysis, also, wounds must ever occupy a foremost place.

As regards the effects of **nerve disease** on wounds, in cases of tabes dorsalis, which I have treated by nerve stretching, I have been struck by the peculiarly torpid condition and slow reparative power in the wounds made in performing the operation, even though throughout a perfect condition of asepticism was maintained.

The tissue changes that occur in **scurvy** are also such as to militate strongly against prompt and satisfactory union in wounds. The tendency to the occurrence in and about the wound of blood effusions probably tends largely to delay reparative action. The injurious effects of a scorbutic diathesis I have observed more markedly in subcutaneous wounds (bone lesions) than in any other.

As regards **rheumatism** and **gout**, it cannot be said that their pre-existence has any specially unfavourable influence on the healing of open wounds. This, however, does not hold good when they are subcutaneous, as in sprains, luxations, fractures, etc. Nor does the converse of the proposition hold good; for operations, some of them of a most trivial nature, appear, in many cases of gout and rheumatism, to stimulate into activity developments of arthritic disease not previously experienced by the patient.

Bright's disease is a serious condition in the face of any operation. The subjects of the disease often recover badly from the anæsthetic, the wound is very apt to take on unhealthy action, and erysipelas is much more liable to supervene than is the case in a healthy individual.

Among other conditions which have been mentioned by M. Verneuil and others, and which injuriously affect the healing of wounds, may be mentioned **syphilis**, **malaria**, **alcoholism**, and **diabetes.**

2. **The condition of health most suited for operation.**—Previously to undertaking any

surgical operation, the condition of the patient's health generally should receive attention. As a rule, excepting in cases of emergency, an operation should not be undertaken until there has been time and opportunity to ascertain if any unfavourable but remediable conditions connected with the patient's health exist. Should the patient be in a low and debilitated condition, rest should be enjoined, wholesome and easily digested food given, and the surroundings made as cheerful as possible. The secretions should be carefully attended to; but, except when absolutely necessary, all medication should be avoided.

The early and middle periods of life, provided the patient has previously led a steady and regular life, are the most favourable for operative interference. Though more susceptible to shock, and less able to bear loss of blood than adults, children, as a rule, bear operations well. Both sexes sustain them equally well, but in females the periods of menstruation and pregnancy should, if possible, be avoided. As regards race and temperament, Dr. Brinton states that the black races and Oriental nations bear operations best; after them the Anglo-Saxons; and then the Latin race. The Chinese and Japanese enjoy, it is alleged, a most remarkable immunity from erysipelas, septicæmia, and pyæmia, which renders them specially favourable subjects for operative interference.

A good deal has been written about certain periods of the year being more favourable for operations than others. I have, however, not observed that any material influence is exercised on operations by any particular season; but at the same time I would, unless there was urgency, avoid undertaking any operative measure of gravity during the prevalence of any exceptional period of heat or cold.

3. **The treatment previous and subsequent to operation.**—Before an operation the

surgeon should consider what instruments or other appliances may possibly be required. There should be as much pre-arrangement and judgment in their selection as discretion in their use. For the success of the operation it is desirable that such details should be attended to, attention to the *minutiæ* of surgery being, as a rule, associated with a corresponding forethought for all other details and contingencies that may arise.

In operating, ostentatious and unnecessary speed and attempts at theatrical display should be avoided, and coolness and *sang froid* cultivated, the possession of which are so essential to meet any serious surgical emergency.

Before performing an operation necessitating any division of tissues, the surgeon should proceed to render the part to be operated on as aseptic as possible. The means for effecting this end are described in the chapter on Wounds.

In the next place, when feasible, he should render the part to be operated on anæmic, which, in a very large proportion of cases, he can do by means of an Esmarch's bandage. When this method is not applicable, then probably digital or instrumental pressure on the main vessel going to the part, or elevation of the limb, or the method by "position," may be had recourse to.

The advantages claimed for Esmarch's method of preventing hæmorrhage during operations may be briefly epitomised :

1. Diminution of shock and consecutive anæmia.

2. No embarrassment to the surgeon from obscurity caused by hæmorrhage in the field of operation.

3. Facilities afforded in examination of diseased bones and joints, and also in searching for small foreign bodies, such as portions of needles, pins, chips of wood, etc.

4. Fewer assistants necessary, and greater rapidity in operating promoted.

The more remote advantages claimed for the method are greater rapidity of healing, diminution of traumatic fever, and a diminished liability to secondary affections such as erysipelas, phlebitis, pyæmia, etc.

As regards diminishing pain and shock in operations, much can be done in the great majority of cases by anæsthetics; and in many instances, when the administration of one is contra-indicated, and the wound is limited in extent, freezing the part by the action of ether spray will be found to answer satisfactorily. Recently, for the diminution of pain, the use of cocaine injected hypodermically has been warmly advocated; but from my experience of it I am disposed to think that the alleged advantages of it have been much exaggerated.

In addition to anæsthetics, many other circumstances tend to influence favourably the results of operations in the present day; among which may be mentioned, greater attention to hospital sanitation, resulting in improved drainage, cleanliness, ventilation, air space, etc., and better nursing.

As regards the wound, the main object the surgeon should have in view is to keep it thoroughly clean and aseptic. If there be much discharge, ample provision should be made for its exit and absorption, for which latter dry sublimated wood wool dressings answer very well. Care should be taken, too, that the position of the patient, with special reference to the part operated on, is such as to be least irksome to him, and that the application of fresh dressings should be attended with the minimum of pain and disturbance. The patient's room should be cheerful and airy, its temperature about 60° F. If there be much gastric irritability after the anæsthetic, iced water taken in small quantities at a time will be found most effectual. For the relief of pain reliance must chiefly be placed on anodynes given hypodermically or by the mouth, the former method being the one usually adopted. The diet, after operations of any severity, should be of the simplest and lightest kind. In cases where there is any evidence of surgical fever, iced milk or milk diluted with soda or lime-water and given in small quantities at a time will be found in most cases to answer well. Later on, if all goes on favourably, chicken broth, jelly, beef-tea, etc., may be allowed, and subsequently a more generous diet may be given ; but so much depends on the particular characters of each individual case that no definite rules about it can be given.

4. Among **the causes of death after operation,** hæmorrhage, primary or secondary, occupies the foremost place. Although there are many instances recorded in which death from primary hæmorrhage occurred during the performance of an operation, so tragical an event could hardly, with the appliances now at our disposal, take place. Secondary hæmorrhage, however, resulting from a variety of causes, such as the slipping of a ligature, its too rapid absorption, or undue reactionary hæmorrhage from too firm and protracted an application of Esmarch's bandage, is not uncommon. I have at times seen, especially in connection with the operation of excision of the knee joint, this bleeding follow from wound sloughing, arterial disease, and an exceptionally rapid re-establishment of collateral circulation. In the pre-antiseptic era venous hæmorrhage was also not unnaturally a source of much apprehension, but now surgeons do not recognise the great peril in ligaturing veins which formerly they had so much reason to dread.

In addition to hæmorrhage there is another cause of death after operations connected with wounds in veins, viz. the introduction of air into them. The accident is one of extreme rarity, and I have never seen an instance of it. In view of this accident occurring, the large veins in the neck are those the surgeon has the greatest fear of wounding, as these are most likely to be attended with this accident. (*See* Art. xxv.)

Another cause of death after operation is shock, which is produced by several causes, among which may be mentioned hæmorrhage, exposure to cold, exhaustion, and mental depression. These causes further the extreme depression of the nervous, circulatory, and respiratory systems, which is so characteristic of well-marked shock, and usually act during or immediately after the performance of the operation. In other cases, however, these phenomena are not apparent until some time has elapsed, and then the condition is termed secondary or cumulative shock, and is often fatal. This latter condition is most likely to supervene in delicate, anæmic, and aged persons exhausted by long-continued anxiety and suffering. Among other and more remote causes of death after operations may be mentioned erysipelas, gangrene, septicæmia, pyæmia, sloughing, embolism, and tetanus.

VIII. ANÆSTHESIA.

JOSEPH MILLS.

ANÆSTHESIA is artificially induced for the following purposes: 1. To prevent pain, as in ordinary surgical operations, and during labour. 2. To produce relaxation of muscles, as in reducing dislocations and herniæ, or setting fractured bones. 3. To assist in making a diagnosis, as in cases of obscure abdominal tumour, and supposed malingering.

At one time it was thought that anæsthetics, especially chloroform, were inadmissible in cases of heart disease; but the only affection of the heart which contra-indicates them is fatty degeneration, which is very difficult to diagnose. And if it be necessary for a patient with fatty disease to undergo an operation, he would be as likely to die of shock from the operation without an anæsthetic as from the anæsthetic properly administered.

Preparation of the patient.—Too much stress cannot be laid on the importance of having a patient properly prepared before an anæsthetic is given; this is, of course, out of the question in accidents or cases of emergency. If the bowels are not acting properly a purgative should be given a day or two beforehand; no food should be taken for four or five hours before the time fixed for operation; should this be early morning, it is best to give nothing after awakening unless the patient is in such a state as to require constant feeding, when a little beef-tea with some brandy or champagne may be given three hours before the operation. It is very important that the stomach be empty at the time an anæsthetic is taken, not only on account of the danger of some food being vomited into the pharynx and causing asphyxia, but also on account of the faintness which accompanies vomiting. This syncope is generally most marked before the vomiting, after which it frequently passes off, though it may continue for some hours. Vomiting is almost sure to occur if the stomach contains food, and it sometimes occurs even when proper preparation has been made. In the former case it lasts much longer, and is accompanied by greater syncope than in the latter.

The administrator should always be provided with a pair of forceps suitable for drawing out the tongue; ordinary dressing forceps answer the purpose admirably.

Artificial teeth should be removed, as in some cases becoming detached during anæsthesia, they have fallen into the pharynx. No anæsthetic should ever be given except in the presence of a third person, for assistance may be required in restraining any struggling or in restoring animation; and because, owing to dreams which sometimes occur during anæsthesia, women have been induced to bring serious accusations against medical men which might easily have been disproved by a third person.

The patient should be in the recumbent position, and should wear none but light garments, which must be loose about the neck and abdomen. The head should not be much raised; as a rule one pillow is better than two, but if two are used, the lower one should be placed partly under the shoulders so as to make a gradual incline, and to prevent the head being tilted forward, and thus obstructing the respiration.

The anæsthetics employed.—The anæsthetics commonly in use are nitrous oxide gas, ether, chloroform, and bichloride of methylene. Nitrous oxide being suitable for short operations only, the choice for ordinary surgical cases rests between ether and chloroform or methylene, the last two being similar in action.

Chloroform and ether.—Sir James Simpson claimed for *chloroform* (the properties of which he discovered in November, 1847) such great advantages as led to its almost universal employment for twenty-five years in the place of *ether*, which had been very generally used since the preceding December, when the discovery of its anæsthetic properties, in America, was first known in England. He considered chloroform superior to ether, in that, a less quantity being required, it is more portable and less expensive; its inhalation and influence are more agreeable and pleasant; its perfume is not unpleasant; its odour does not remain attached to the clothes of the attendant, or exhale in a disagreeable form from the lungs of the patient; no special kind of inhaler is required, and its action is more rapid and complete, and generally more persistent. With the exception that, by modern improvements in inhalers, the action of ether has now been rendered more rapid and quite as complete as chloroform, all these advantages for chloroform must be allowed to hold good. Indeed, it has yet another advantage, in that it does not so greatly irritate the air passages. But ether possesses over chloroform one advantage so great as to more than turn the balance in its favour; for whereas ether stimulates, chloroform is apt to depress the heart's action. During the administration of chloroform there is sometimes very alarming syncope, which rarely occurs with ether; and it appears, from experiments on animals, that the heart may be paralysed by the former and not by the latter. Then, again, the vomiting, which frequently accompanies the administration of an anæsthetic, as a rule lasts longer after chloroform than after ether.

When ether is not to be given.—Ether, then, seems to be the safer, and so should be used in all suitable cases; but in the following cases, for the reasons mentioned below, ether is not recommended :

1. Children.
2. Old people.
3. Midwifery.
4. Operations on mouth or nose.
5. Operations on the eye.
6. Ligature of large arteries.
7. Abdominal section.
8. Setting of fractures.
9. Obstructed respiration. Laryngitis. Bronchitis. Emphysema. Phthisis. Empyema. Patients under opium. Advanced kidney disease.

1. Children under ten or twelve years take chloroform well; but are readily asphyxiated by ether, and are frightened by the apparatus.

2. People over sixty or sixty-five years take chloroform well, with little, if any, struggling; but are greatly irritated by ether, especially if, as is frequently the case, there is a tendency to bronchitis.

3. As the first stages of the inhalation of ether are far more unpleasant than those of chloroform, and as these only are requisite during the pains of labour, chloroform, which is exceedingly well borne in these cases, is preferable.

4. As the influence of chloroform lasts longer than that of ether, it is preferable for operations on the mouth and nose. In these cases it also possesses other advantages, in that it may readily be given on a piece of lint, or better still, through a tube inserted into the mouth or nostril, without obstructing the operator; moreover, its administration is not so likely to be accompanied by coughing, it does not occasion such a flow of viscid saliva, and does not produce so much hæmorrhage. These, in operations such as that for cleft palate, are important considerations.

5. In operations on the eye, chloroform may be given on lint without obstructing the light or

impeding the operator's hands, as sometimes happens with an ether inhaler; and as its administration does not cause so much congestion and hæmorrhage, it is generally preferred.

6. For the ligature of large arteries such as the subclavian, chloroform is preferable, because the veins are so distended during the administration of ether as to render the operation more difficult and more dangerous.

7. Some ovariotomists are of opinion that ether, by causing much oozing of blood into the peritoneal cavity, adds to the danger of abdominal sections, and therefore prefer chloroform for these operations.

8. In cases of fracture, which require an anæsthetic whilst the parts are being placed in apposition during the time the muscles are relaxed, chloroform is preferable, because patients recover from its effects quietly, the inhalation of ether being sometimes followed by a state of delirium and struggling which would be likely to displace the fractured ends of the bone and necessitate their readjustment.

9. Patients who are suffering from difficulty in breathing from any cause whatever, and patients under the influence of opium, and those suffering from advanced kidney disease, not only take the ether badly, but its inhalation in some of these cases is likely to be followed by bronchitis or hæmoptysis, in others by a drowsy state, in which the patient may gradually die.

ADMINISTRATION OF CHLOROFORM.

The pure chloroform only should be used; Duncan and Flockhart have the reputation of being the best makers. No inhaler is better than a piece of lint about twelve by six inches, folded so as to form a square of about six inches, on to which the chloroform may be sprinkled from a small drop bottle. It is well to commence with about five drops of chloroform on the lint, which should be held about two inches from the patient's face, just to allow him to become accustomed to the vapour. In a few seconds, without removal of the lint, a little more chloroform may be added, and the lint turned so that the wet side may be towards the face. The quantity of chloroform sprinkled should be slightly increased each time. Care should be taken that the part of the lint which is wet with the chloroform does not touch the face, as it is apt to blister.

At first it is unadvisable for the patient to be held, but when excitement is produced he should be restrained sufficiently to allow the administration to be continued, and to prevent his doing any damage with his arms or legs; but it is not necessary, as a rule, to keep him absolutely still, for in most cases the greater the restraint the greater the struggling. Adults struggle most, and men more than women; the subjects of delirium tremens and drunkards always give great trouble during this stage; but in any case the struggling is least when the administration is regular and gradual. This being the most dangerous stage (the stage during which death is most likely to occur) demands in all cases the utmost care and attention. When an unusual amount of excitement occurs the administration should be continued unless the respiration be impeded, in which case it should be discontinued for a few inspirations. If a sufficient quantity of chloroform be not given at this period, either the struggling will be unnecessarily prolonged; or, some recovery from the effects having taken place, perhaps two or three of these stages will be induced in the one administration. Whilst struggling the respiration is often very deep; care must, therefore, be taken that the vapour be not given too strong. The muscular excitement generally subsides gradually, and the patient passes into a state of slumber, with more or less snoring, after from five to seven minutes' inhalation. It is well to stop the administration for a few seconds as soon as the patient is under the influence, especially when there has been much struggling, because, owing to the cumulative property of chloroform, its effects often become more intense after its administration has ceased.

A patient is generally said to be ready for the operation to be commenced, when touching the inner border of the eyelid or ocular conjunctiva with the finger produces no reflex action. In some cases it is necessary that touching the cornea, which is far more sensitive than the conjunctival covering of the sclerotic, should produce no reflex. But the eye is by no means a certain test, as its sensibility varies so much in different people; and the patient cannot usually be said to be "ready" unless, in addition to loss of reflex action of the conjunctiva, there be also general relaxation and more or less snoring.

After induction, anæsthesia should be maintained by small quantities of chloroform frequently applied, rather than by larger amounts applied only on the reappearance of reflex action. If at any time reflex action be observed, a small quantity of chloroform is sufficient to very soon produce a more profound anæsthesia; but a larger dose is both unnecessary and dangerous, on account of the deeper inspirations which accompany the other reflex movements.

During the struggling stage the pupil sometimes becomes a little dilated, but when fully under the influence it is slightly contracted, and acts with light. In very deep narcosis only, such as is sometimes necessary in operations on the more sensitive parts as the eye, genitals, or anus, does it fail to act with light. Dilatation occurring during thorough narcosis should be regarded as a signal of danger, and the administration should be stopped. Lividity and extreme pallor of the face are each signals for stopping the administration.

The pulse often gives the first warning of approaching danger, and is, therefore, to be carefully watched from the beginning to the end of the administration; should it become feeble, irregular, or intermittent, the chloroform must be immediately stopped, and preparation made to apply restorative means.

With regard to the respiration, it is not sufficient to watch the chest walls and abdomen, the movements of which often continue when no air is entering the lungs; but it is necessary also to listen to the breathing, especially when there is any doubt as to its efficiency. Obstruction may take place in the bronchi, trachea, larynx, or pharynx, from blood or vomit. Most frequently it is in the pharnyx, and is caused by the falling back of the tongue; or the approximation of the glottis to the back of the pharynx, from the head being tilted forward with the chin too near the sternum. It may generally be remedied by a change of position of the head, by drawing the chin forcibly from the sternum, or turning the face to one side to prevent the tongue falling back. If the obstruction be not at once removed by these means, there should be no delay in seizing the tongue with forceps and dragging it out of the mouth, and sponging out the fauces; should this not have the desired effect, artificial respiration must be resorted to; and if the entrance of air be still obstructed, tracheotomy must be performed without delay.

In some patients who are not able to breathe freely through the nostrils, it may be noticed that when under an anæsthetic the lips become pursed up, or flap together like a valve, entirely preventing the entrance of air; it is, of course, easily remedied by separating the lips, though the lividity produced by it has been known to cause alarm. Infants, after the completion of operation for hare-lips, very often are unable to breathe properly unless the lower lip be drawn down by the finger; they, therefore, require careful watching during recovery from chloroform.

The greatest danger which attends the administration of chloroform is *syncope.*

This may be produced by giving too large a percentage of chloroform to air, or by an overdose, or by shock from the operation. Shock is most often noticed when, in the operation for strabismus, the internal rectus is divided, the pulse sometimes intermitting and remaining feeble for some minutes. Syncope may also be caused by the loss of blood during the operation, or it may accompany vomiting.

When the face becomes pale and bedewed with a cold sweat, the pulse weak, slow, or irregular, and the respiration slow and shallow, no matter what the cause of these symptoms may be, the chloroform must be immediately stopped and the administrator must be prepared to apply restorative means. Sudden stoppage of the circulation and respiration have been said to occur simultaneously under chloroform without the slightest warning; but there is no doubt that, before stopping, the pulse often becomes more and more feeble and then imperceptible; the respiration for a few seconds continues, and becoming more and more shallow, ceases also.

The following directions for *restoring animation in cases of extreme syncope* will be found useful.

Seize the tongue with forceps and draw it forwards. Compress the sternum forcibly, allowing the chest of its own elasticity to expand; do not wait for the respiration to cease before doing this, for by making respiration forcible by artificial means in this early stage the heart may be stimulated.

The pillow should be removed from beneath the patient's head; and if, after two or three compressions of the chest, matters are improved by this treatment, continue it; if not, the patient should be suspended by the legs, head downwards, and the respiration continued by placing one hand on the back and the other on the sternum. Although it may be argued physiologically that this plan is mischievous, there is no doubt that, in practice, Nélaton's method of total inversion of the body, combined with artificial respiration, is the most efficacious remedy for severe chloroform syncope. As a rule the pulse and respiration are immediately improved by this plan, and it frequently happens, when the patient is replaced in the recumbent position, that pulse and respiration again fail; it is advisable, therefore, to be prepared if necessary to invert the patient a second time.

As total inversion of a heavy patient is not always practicable, the mention of other means of resuscitation must not be omitted. Sylvester's method of artificial respiration has proved successful on many occasions. If this does not at once succeed, it, or Howard's plan, should be continued, and, if necessary, persevered with for half an hour, or as long as there is any hope of recovery. Ether may be injected subcutaneously. The faradic current may be applied, one pole to the epigastrium, the other to the right side of the neck, to try to induce the diaphragm to act. A hot water bottle may be applied to the feet and friction to the legs; fresh air may be admitted by opening the windows and doors; warm blankets should be thrown over the patient, and an enema of brandy may be given.

Holding nitrite of amyl or ammonia to the nostrils, and dashing cold water on the face and chest, are remedies which may be useful for slight syncope, but are not to be relied on in tho more alarming cases, when the administrator should not for one moment neglect the artificial respiration for any less efficacious remedy.

Bichloride of methylene, or **methylene,** as it is now called, is preferred to chloroform by Sir Spencer Wells, who thinks it is followed by less sickness. It is said by some to be merely a mixture of alcohol and chloroform, in the proportion of 1 to 4. Its action is similar to that of chloroform, but it is much more expensive.

It may be given in a felt or leather mask; but the best inhaler is Junker's, which is equally suited for the administration of chloroform.

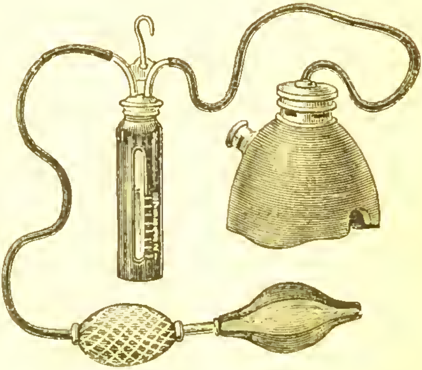


Fig. 2.—Junker's Inhaler.

Junker's inhaler consists of a graduated bottle capable of holding about 2 ozs., closed by an air-tight fitting top, through which two tubes are made to pass, a long one communicating with hand-bellows, and extending to the bottom of the bottle, and a short one commencing at the top of the bottle, and connected by a flexible tube with a vulcanite face piece. In using the apparatus, about six drachms of the anæsthetic should be poured into the bottle, which is to be hooked on to the administrator's coat (if more than six or seven drachms be put in, some of the fluid is likely, on forcible pressure of the bellows, to overflow into the face piece). The face piece should be held quite lightly over the patient's face, and very gentle pressure of the bellows may be made at each inspiration. The quantity of the vapour is regulated by the frequency and amount of pressure on the bellows.

For maintaining anæsthesia throughout long operations on the mouth and nose, it will be found useful, after the induction, to substitute for the face piece a flexible metallic tube or gum elastic catheter, which may be inserted into the mouth or nostril; by this means anæsthesia may be kept up for an indefinite time without in any way obstructing the operator.

ADMINISTRATION OF ETHER.

The ether which should be used for inhalation is that which in the Pharmacopœia is described as pure ether, sp. gr. ·720; or, what is much cheaper, and apparently quite as good, is the anhydrous ether, made from methylated spirit, by Macfarlane and Co., of Edinburgh. Owing to its very volatile and inflammable nature, care should be taken that a lighted candle be not held too near. It may be given in a towel folded into a conical shape, to fit the face, or in a felt or leather mask; but when used in this way it is very disagreeable, takes a long time to produce sleep, causes considerable excitement, is very extravagant, and saturates every one in the room with its vapour.

The simplest and best way of giving it is either by Clover's or Ormsby's ether inhaler. The principle on which these two act, in making the respirations pass to and from an indiarubber bag over the ether, is the same, though the means employed differ. Clover's, which, though the more expensive, is generally preferred, contains fluid ether, and has a dial for regulating the amount of ether vapour; while Ormsby's contains a sponge, to be saturated with an ounce of ether, and has a valve for regulating the amount of air.

Clover's ether inhaler.—"The object of this instrument is to induce anæsthesia, in part by the diminution of oxygen respired, and to regulate the strength of the ether vapour, so that it may with certainty produce the degree of quietude wanted, and yet may not cause coughing or great difficulty of respiration."

The inhaler consists of a face piece with an indicator, which by rotation may be made to point to 0, 1, 2, 3, or F, on the circumference of the metallic vessel containing fluid ether; and of a bag, into and from which the patient breathes. It is so constructed that when the indicator is at 0, the expired and inspired air passes to and from the bag, without in any way communicating with the ether chamber. If the indicator stand at F, the whole of the expired air must pass through the ether vessel to the bag, and at inspiration return from the bag through the ether vessel. When the indicator is at 2, half of the respired air passes to and from the bag direct; the other half passes through the ether vessel; and so on for the other numbers. The air does not pass through the ether, but simply through the vessel containing it, and this is sufficient to carry off a large amount of its vapour.

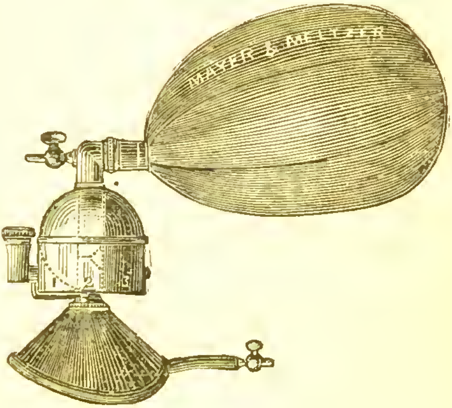


Fig. 3.—Clover's Inhaler.

Not more than an ounce and a half of ether, or two-thirds of the quantity which the measure supplied with the instrument is capable of holding, should be poured into it, or some is likely to be splashed over on to the patient's face. With the indicator at 0, the inhaler should be applied lightly to the patient's face; it should be raised a little during each inspiration, and held more firmly during expiration, until the bag is moderately distended, when it is no longer necessary to raise it. After a few respirations the ether vessel may be rotated so as to bring the indicator nearer to either of the figures 1. Let us suppose each of the intervals between 0, 1, 2, etc., to be divided into six *spaces*. It will be found sufficient to rotate the vessel one *space* at a time. The rotation may be continued during every second or third expiration, unless the patient show any signs of discomfort, when it is advisable to turn it back a little. The ether must be turned on very gradually to enable it to be freely inhaled. Allowance must be made for the degree of tolerance of the vapour which exists in different individuals; if the respirations are shallow, it is well not to increase the vapour so frequently as when they are full and forcible, which shows that no irritation is being produced.

Should the bag become empty, as often occurs if the face-piece be not applied sufficiently firmly during expiration, it should be raised for one inspiration and re-applied in time to catch the expiration. While the inhaler is applied to the face, there being no communication with the external atmosphere, the same air is respired over and over again, so that it is necessary to frequently remove it for an inspiration of fresh air. As a rule, while anæsthesia is being induced, an inspiration of air should be given every half minute, and after it has been induced, every three or four inspirations from the inhaler should be followed by one of air.

If the patient at the commencement of the administration show any signs of intolerance (by swallowing, coughing, or endeavouring to remove the inhaler), it is advisable to admit one inspiration of air, and for a time give the vapour less strong; omission of this will give rise to struggling, which by the beginner is often mistaken for ether intoxication which immediately precedes anæsthesia. It should be remembered, therefore, that struggling (which really ought not to occur at all with proper administration) may be from two causes requiring different treatment; that at the commencement is due to intolerance, and may be stopped by giving one inspiration of air, and then recommencing a more gradual administration; the other is due to intoxication, and may be cut short, after admitting one inspiration of air, by keeping the inhaler firmly applied, and increasing the vapour by rotating two *spaces* at a time instead of one. In warm weather it is rarely necessary to go much beyond figure 2, or in cold weather beyond figure 3. After two or three minutes, anæsthesia is complete. There is at first considerable congestion of the face, sometimes slight lividity, which soon passes off on admission of a little air. The sensibility of the conjunctiva is impaired, but not destroyed.

The chief indication of complete anæsthesia is the deep snoring. There is sometimes a slight spasmodic twitching of the muscles, which is apt to lead the inexperienced to imagine that the patient is not fully under. By giving the vapour more strongly this twitching will be found to increase; but if, on its occurrence, air be admitted more frequently, these spasmodic movements will soon pass off. A very much smaller quantity of ether is required to maintain than to produce anæsthesia, and the longer it is continued, the less ether and the more air may be given. After about ten minutes another half measure of ether will probably be required. Any disturbance of the pulse or respiration may generally be remedied by diminution or discontinuance of the vapour; the respiration may often be improved during profound anæsthesia, by drawing the chin away from the sternum.

To avoid the discomfort of the commencement of the inhalation of ether, it is useful to begin with nitrous oxide gas. The addition to the above apparatus of a stopcock, to which may be attached a tube for the admission, and of a valve for the exit of the gas, will enable it to be used for this purpose. Better still is Clover's gas and ether inhaler, which may be used for gas or ether alone, or the two combined. Another plan is to begin with any gas apparatus, and then substitute a Clover's or Ormsby's ether inhaler. Or it may sometimes be found useful to use chloroform until the air passages become less sensitive.

Nitrous oxide gas is the safest anæsthetic to give, and the most pleasant to inhale. Its administration is never accompanied or followed by sickness, nausea, or headache, and it is not necessary to make much alteration in diet before or after its inhalation.

It may be obtained from Coxeter or Barth, compressed into the liquid form, in iron bottles of various sizes, those which contain fifty gallons being the most useful. As the label on each bottle shows its weight when full and when empty, the quantity contained in a bottle may at any time be readily ascertained by weighing it. The weight of fifty gallons is fifteen ounces, and this is generally sufficient for about ten administrations, so that on an average each patient takes about five gallons by measure or an ounce and a half by weight.

For the successful administration of gas it is of the utmost importance to exclude all air; this is ensured by a well-constructed apparatus with good valves, and above all things by a well-fitting face piece. It is a good plan, especially with nervous patients, to allow them to breathe air through the face piece before turning on the gas. After inhaling for about one minute the breathing becomes stertorous, the face congested, and there is total anæsthesia; but if the nature of the operation be such that the administration cannot be continued during its performance, it should not be commenced until after three or four stertorous inspirations. If continued beyond this without admission of air there is great lividity, spasmodic twitching of the muscles, dilatation of the pupils, and probably opisthotonos, and in women paralysis of the sphincter of the urethra.

In dental operations it is necessary, before commencing the administration, that a prop attached to a string be placed between teeth, at a distance from those to be extracted, to keep the mouth wide open. In addition to this the administrator should be provided with a more powerful gag with which he can quickly open the mouth during anæsthesia, in case the prop from any cause be displaced.

Any difficulty with the respiration is generally at once relieved by one or two compressions of the chest. Faintness is best treated by the recumbent position, and ammonia or nitrite of amyl.

The A. C. E. mixture.—To do away with the depressing effect of chloroform and the irritation of the air passages by ether, many combinations have been employed, the favourite being that commonly known by the name of the A. C. E. or 1. 2. 3. mixture, which consists of alcohol 1, chloroform 2, and ether 3 parts.

It must be borne in mind that this is merely a mechanical mixture, no new chemical compound being formed; and it is a mixture of liquids of different specific gravities, boiling points, and rates of volatility. It follows, therefore, that in its employment care must be taken (1) that it be quite fresh, (2) that no form of inhaler be used which will allow of the accumulation of the heavier fluids after the evaporation of the more volatile.

Treatment during recovery. — When a patient is recovering from anæsthesia, perfect quiet should be observed, in the hope that natural sleep may ensue, the awakening from which is more agreeable and less likely to be followed by sickness. Nothing, but perhaps small pieces of ice to suck, should be given for at least two hours, and then only a little soda-water and milk or a cup of tea; even when no vomiting has occurred, it may sometimes be induced by feeding too soon after recovery.

Local anæsthesia may be produced by cold, either by the application of a freezing mixture of ice and salt, or more perfectly by ether spray; but the objections to this are that frozen tissues are difficult to operate on, and that the thawing is sometimes accompanied by acute pain. Carbolic acid painted on the surface of the skin will diminish its sensibility sufficiently for opening a superficial abscess.

Muriate of cocaine in solution produces complete local anæsthesia of mucous surfaces. Two or three applications, at intervals of five minutes, will in about ten minutes produce local anæsthesia of the part to which it is applied, and lasts for a quarter of an hour. In ophthalmic surgery, for which it has been most successfully employed, a two per cent. solution is sufficient for the removal of foreign bodies, but for operating on the cornea a four per cent. solution is necessary. For operations on other mucous membranes, a ten or even a twenty per cent. solution is advisable.

Its action is unsatisfactory on inflamed tissues, they being apparently incapable of absorbing it. It has also been employed, but with varying success, subcutaneously injected.

IX. SHOCK.

PROF. FURNEAUX JORDAN.

Shock may be described as a depression of all the functions, the result of a powerful impression applied to the nervous centres or some portion of the nerve periphery. The impression (injury, or operation, or mental disturbance) acting on the nervous system affects every organ connected with it. The heart is chiefly impressed, and impaired cardiac action, affording a diminished supply of blood, induces an aggravation of all the symptoms, and gives some of them peculiar characters. Indeed, the most striking evidence of shock is seen in the circulating organs. Brunton shows that shock is mainly due to paralysis of the heart and vaso-motor paralysis of the abdominal vessels. The sudden dilatation of the abdominal vessels may simulate sudden hæmorrhage.

There are some poisons which give rise to shock by acting directly on the muscular fibre of the heart; such are the upas poison and cyanide of potassium, when injected into the blood.

The partial or complete cessation of muscular action is very marked in shock. Muscular actions are of two kinds: those which take place through the instrumentality of the spinal cord and medulla oblongata, and those which are the direct manifestations of the psychical power. The first set of actions comprise the excito-motor or reflex, as well as the sensori-motor or consensual; while those of the higher seats of origin of nerve power are those educed by the feelings, the ideas, and the will. In shock, the most exalted of these are the first to be impaired or suspended; the impairment is attended with little danger. It is not so as we descend in the scale of nervo-muscular action. When sensori-motor action is arrested, life itself is in danger; and when excito-motor action in some of its manifestations (the suspension of all excito-motor action, it is needless to say, is inconsistent with life) is impaired, a fatal termination is extremely probable.

The causes of shock are numerous; they may be classed under four heads: 1. Those which act on the corporeal organisation. 2. Those which act on and through the psychical functions. 3. Those which are both corporeal and psychical in equal or unequal degrees. 4. Cold, which, though fully recognised by physiologists, has somewhat escaped the attention of surgeons. Poisons may be classed under the first head.

The greater number of cases of shock are found under the third head, where both bodily and mental causes contribute to the effect, such as burns, extensive wounds, operations, bites of poisonous animals. Irritant poisons act in a similar manner to burns or irritants on the surface. The causes which act purely through the medium of the psychical functions are the more powerful emotions: joy, grief, anger, fear. When these causes lead to a fatal result it will usually be found that some disease of heart or brain is present. Causes which act purely on the corporeal organisation are rare; the sudden emptying of an habitually distended bladder or the rupture of an internal aneurism may be cited as examples.

The symptoms of shock correspond for the most part (not invariably or under all circumstances) with the severity of the cause. In the severest cases, as after the crush of a limb, or the opening of a large joint, or gangrene of a portion of bowel, the injured person is found motionless, on his back, or as placed by bystanders; he is cold, perhaps covered with a cold sweat, and pale in lip and skin; the eye turned upwards, the upper lid depressed; the conjunctiva lustreless or even "glazed." The features are contracted, the lips are parted and thin. If the shock be due to continued loss of blood, great restlessness and tossing of the limbs will take the place of muscular inaction.

It is commonly said that the action of the heart is accelerated by shock. Probably in every case there is at first, for a longer or shorter time, diminished frequency of the heart's action. Consciousness, the intellect, the sensibilities are blunted, and the will is paralysed. Deglutition may be difficult, and the contractility of the sphincters lost. The urinary secretion and glandular activity generally are retarded or arrested. The respiration is feeble, quickened, and irregular. Nausea and vomiting may be present. The temperature is lowered.

In order to give greater precision to our knowledge of shock, I have used the thermometer in many instances of its severer forms. The temperature may descend to 97° or even 96°; its descent below 97° is not frequent. A remarkable incident which I have found to occur in amputation of the thigh is this: the very moment the saw comes into action in dividing the bone, the temperature suddenly falls from a tenth to a fifth of a degree; no change is seen when the soft parts are cut, whatever the extent of the incision may be.

Shock has many **varieties,** and circumstances may considerably modify its phenomena. It is more marked in the so-called "nervous" temperament. It is less marked in calm and hopeful temperaments. Extreme excitement, as in battle, may delay, but, probably, it does not avert the symptoms of shock. Its phenomena are intensified by prolonged or severe pain.

Certain injuries to the head produce a peculiar form of shock, which is known as concussion of the brain. Consciousness, intelligence, and the emotions, are more or less in abeyance, while the sensori-motor and the excito-motor functions are, perhaps, but slightly impaired. A stun or jar to the nerve centres may thus give rise to apparently more intense shock than a limb injury which is about to prove fatal.

The influence of *sex* and *age* on shock is of great interest. I am of opinion that women, other things being equal, bear injuries better than men. I am assuming, however, that the nervous system is less taxed than it is in men.

Patients of advanced age, presuming that the age is not extreme, that the internal organs are sound, and the habits temperate, often bear shock remarkably well. When old age is associated with disease of important organs shock is frequently severe. Often the shock *seems* less intense, but it persists, and, when we least expect it, it may prove suddenly fatal. Chronic and relapsing forms of shock are met with in very feeble and in ailing persons. Children, it is commonly supposed, suffer severely from shock. Children suffer more than adults from cold, or loss of blood, or absence of nourishment, but probably they bear injuries and operations better than adults. The explanation which I offer, and which is based on experiments on animals performed for me some years ago by a distinguished physiologist, Professor Norris, is this: The lower the manifestation of vitality, so far as this is tantamount to the manifestation of nervo-muscular force, the less the susceptibility to shock from injury. Where nerve force is predominant shock also becomes predominant. On this principle, the person with old joint disease worn to mental and bodily torpor, and the young child whose force is developmental rather than nervous, bear operations and injuries better than a man in the prime of life, whose every organ and function are subservient to the exercise of nerve force. *Disease* has a more important bearing on shock than either age or sex. Cardiac, pulmonary, hepatic, and, above all, renal ailments, lend a peculiar risk to operative proceedings.

The principal feature in railway accidents is the combination of the psychical and corporeal elements in their most violent forms, and the resultant shock is more than ordinarily severe.

Reaction, with all the incidents which accompany increased vigour of circulation, follows on shock. It may be slight or severe, but in bodily injuries and in operations much of the febrile action, which was once attributed to reaction, is now, with greater justice, put down to septic change.

The **death** after shock is usually due to syncope or asthenia. The syncope is of two kinds. In one there is sudden and extreme spasmodic contraction of the heart, the heart remaining empty and contracted. Very much more frequently the heart simply ceases to beat, and its cavities contain more or less loosely coagulated blood. When the death itself is exceedingly slow and protracted, decolorised clot may be found

The **treatment** of shock is for the most part of a negative character. Where the head is not injured stimulants may be given; into the rectum in extreme cases. A little opium is often of benefit. If brandy stimulates and opium produces drowsiness, the prospect is so far more favourable. Probably the one great remedy for shock, and we owe this knowledge to experiment on animals, is the early application of heat. Hot air is the best form of using heat, the hot bath comes next; a goodly number of hot-water bottles are also efficient. After all the severer operations the application of numerous hot-water bottles, even in summer, should not be neglected. In the hottest weather, loss of blood and the shock of an operation give rise to a feeling of distressing coldness.

In operations, at any rate, something may be done to lessen or prevent shock if it be true, as I have attempted to show, that shock is always most marked where nerve function is highest in character and more intense in action. The maximum of shock is in the adult man whose will and ideas predominate over all other functions; the minimum of shock is seen in the young, the feeble, and the old, so long as youth, debility, or age, is indicated by blunted or altered nerve force only. May we not imitate this bluntness of the higher nerve forces by enforced and prolonged indolence in bed, by mild opiates, or chloral, or even some approach to alcoholism, or in some cases by slight etherisation for many hours before sudden, unexpected, and severe operations?

X. TETANUS.

Jonathan Hutchinson, Jr.

This terrible disease is met with at all ages, and in the most healthy persons. Males from fifteen to forty-five are the most frequent sufferers, because they are most exposed to wounds, but females are by no means exempt, especially after burns. In Europe it is but little known except as a complication of wounds, and of these a contused and lacerated one (followed by decomposition and suppuration) is most likely to produce it, especially under certain atmospheric conditions, which at present we can only ascribe to sudden changes of temperature and degree of moisture. All authors are agreed as to the occasional influence of chill in its causation.

During the campaign in the Caucasus, the weather being persistently cold, Pirogoff saw hardly any cases amongst the Russian wounded; whilst after some battles the mortality from tetanus has been very heavy. Tetanus sometimes seems to occur in epidemics; thus, in 1782 one out of every six infants born in the Rotunda at Dublin died within the first fortnight after birth from this disease. In infants it is probably set up by the ligature of the umbilical cord.

In 1858 there were five cases of tetanus from operations on piles in St. Mark's Hospital, whilst since then there has not been one; during that year the disease was often met with in London.

No wound is free from the risk. Even the introduction of a hypodermic needle, a slight graze of the skin, and the extraction of a tooth have been followed by severe tetanus. It is important to remember that a foreign body embedded in the tissues (sometimes in a nerve) is liable to set it up.

Symptoms.—The rapid course of acute traumatic tetanus may be illustrated by the following case:

An engineer, aged thirty-seven, had one hand severely torn; antiseptics were used, but they broke down and the flap became gangrenous. The temperature, which since the accident had been about 100°, rose on the sixth day to 102°, and at the same time he complained of severe pain in the head and "soreness of the throat." Trismus (rigid closure of the jaws) and dysphagia now became marked, and were accompanied next day by severe spasms all over the body, both constant (tonic) and in violent outbreaks (clonic). The difficulty in swallowing being extreme, a tube was passed through the nose, but this brought on a terrible spasm, in which he died. The temperature just before death was 104°. The case was thus fatal on the seventh day after the accident, and within twenty-four hours from the onset of tetanic symptoms.

Even more rapidly fatal cases, in which death has ensued after a few hours, are recorded amongst negroes in the tropics, who appear to be peculiarly liable to tetanus.

As a rule, no rise of temperature occurs at the onset of tetanus, and indeed this may be absent throughout. On the other hand, it sometimes attains a phenomenal height shortly before, or just after death, even 112°. Increase of pain in the injured part, the restlessness and anxiety of the patient, and especially the trismus and difficulty of swallowing, first arouse suspicion as to the disease.

The spasms are generally symmetrical, the chief exceptions being cases in which the muscles of the injured limb are especially involved, and the rare cases of *pleurosthotonos*, in which the body is strongly bent to one side.* Besides the tetanic rigidity which is so characteristic, and which can best be observed in the muscles of the jaws, the neck, and the abdominal

* The head and neck are usually bent backwards, and the back arched (*opisthotonos*); rarely it is bent forwards (*emprosthotonos*). The mouth is sometimes drawn outwards and the eyebrows elevated, so as to produce a sort of grin (*risus sardonicus*).

wall, violent clonic outbreaks occur from time to time, sometimes excited by dressing the wound, a draught of air, etc. During a severe one the patient is threatened with death from asphyxia, and after it the exhaustion and profuse perspiration are very marked. Spasm of the deeper muscles, such as the diaphragm and psoas (rupture of both the latter has been several times found after death), may be present at the same time.

The following features may be associated:

1. Perspiration profuse; fluids taken with difficulty; urine high-coloured and scanty; sudamina on the skin.

2. Violent and continuous spasm of the voluntary muscles; obstinate constipation, and sometimes retention of urine.

3. Fever slight or absent; pulse slow and perhaps soft. A quick pulse (if observed in intervals of comparative quiet) is a sign of approaching syncope or exhaustion, and it has been asserted that if it exceed 120 per minute the case will end fatally. Rapid breathing is of less grave import, and is nearly always met with. The intellect usually remains clear to the last, sleeplessness (unless defeated by the use of chloral, etc.) is constant, but towards the end a deceptive calm from exhaustion is occasionally present; delirium is sometimes met with, but may then be due to the drugs used (*e.g.* atropine). Death often occurs during asphyxia from laryngeal spasm, less frequently from exhaustion, and in a few cases from hyperpyrexia.

Irregular contraction of the diaphragm may produce a spasmodic cough; a "girdle pain" is supposed to be of particularly bad prognosis, as indicating pulmonary obstruction.

The so-called *idiopathic* form of tetanus appears to be largely due to exposure to chill, and is less fatal than the traumatic one.

Prognosis.—The great mortality of tetanus after wounds may be judged from the fact that of 363 cases in the American Civil War, 336 died (Gross). The same author states that during fifty years' experience he has only known three cases recover. A considerable interval (ten days to three weeks) between the wound and the first symptoms is of good augury, but severe and fatal cases are seen with a "latent period" of several weeks. Rapid development and severity of the symptoms are, of course, grave features in the case, and if the patient survives more than a week, his chance becomes better every day. The majority of deaths occur within the first five days. In those cases which recover the symptoms last on an average about a month, the intervals between the spasms becoming longer and longer, and the spasms less severe.

Diagnosis.—1. *Trismus*, when not a part of tetanus, is nearly always excited by local irritation, such as the extraction of a tooth or the cutting of a wisdom tooth; it does not spread to other muscles than those of the jaws; the spasm is tonic only, and may subside in a few hours, or gradually pass off in a few days.

2. In *spinal meningitis* there is fever from the first, and there are no marked convulsive attacks. The latter remark applies also to rheumatism of the cervical muscles.

3. In *hydrophobia* the spasm wholly intermits, and a fresh one is set up by the sight of water, there being no aversion to this in tetanus, merely a difficulty in swallowing, and that not in all cases. Melancholia, hallucinations, outbreaks of screaming or barking, and free discharge of saliva, are peculiar to hydrophobia. (*See* Art. XXXII.)

4. *Strychnia poisoning* usually affects the whole muscular system rapidly (the masseters amongst the

last). Its onset may be announced by retinal hyperæsthesia, or disturbed colour vision; between the convulsions there may be no tonic contraction. Marked foaming at the mouth may be present, as in hydrophobia, and the teeth are gnashed together rather than tightly clenched, hence the tongue is more likely to be bitten. Death supervenes, as a rule, within an hour or two. The resemblance of the two in other respects is very close, and strongly points to the real nature of tetanus.

5. *Hysteria* may closely simulate tetanus, but the phenomena due to spasm of the diaphragm are absent. The symptoms are much milder, and may cease when the patient believes he or she is out of observation. Dysphagia and sleeplessness are absent as a rule.

6. *Tetany* appears to be allied to hysterical contraction; it affects the hands and feet by preference, occurs almost entirely in children and women. It could hardly be mistaken for tetanus.

Pathology.—Various parts of the brain and spinal cord have been found congested and softened; on the other hand, these structures often appear normal. Mr. Pepper in one case described peculiar rounded patches of degenerated nerve tissue, but this change is neither peculiar to, nor frequent in, tetanus.

The nerves near the wound may be inflamed or normal; the lungs are usually engorged or inflamed; the endocardium stained, etc. Various muscles, such as the recti and psoas, are occasionally ruptured.

Two chief views are held as to the real nature of tetanus, and upon the importance attached to each must depend to some extent the treatment.

I. That the spasms are reflex, and due to irritation or inflammation of peripheral nerves. In its favour are the cases of tetanus set up by foreign bodies embedded in nerves; against it is the extreme rarity with which it follows operations or accidents in which nerves are torn, ligatured, contused, etc. Were this theory correct, amputation and nerve stretching or excision, as measures of treatment, would surely be followed by better results than is unfortunately the case.

II. That some poison (allied to strychnine and the ptomaines) is generated in the wound, and acts by selection on the motor nervous centres. Amongst the facts pointing to this conclusion are: (1) The resemblance of tetanus to strychnine poisoning and to hydrophobia; (2) a contused wound, in which decomposition must occur, is commonly the starting point; (3) a poison has been extracted from human urine which tetanises animals. Inoculation with the blood from tetanic cases has hitherto failed, but it will be remembered that M. Pasteur, in producing hydrophobia, employs pieces of the brain and spinal cord.

Treatment.—On the first appearance of symptoms the patient should be kept in a private ward, the air of which is warm and dry, and all excitants of spasm, such as frequently dressing the wound, should be avoided. If the wound is very unhealthy, and on a comparatively unimportant part, immediate amputation is perhaps worth trial; otherwise, a warm antiseptic dressing should be applied. Nerve stretching or excision seems only worth doing if the local pain is severe, and if the transmitting nerve can be identified.

The bowels should be freely cleared by enema or purgative, and nutrient enemata may subsequently become necessary; though the use of sedatives or an anæsthetic with a gag has fortunately removed much of the old difficulty in giving nourishment, which should be concentrated and taken at considerable intervals.

The following are the chief sedatives used: chloral, bromide of potassium, calabar bean (better its alkaloid eserine), curare, belladonna, and opium or morphia. Whichever is selected, the surgeon should push it freely until some relief from spasm is obtained; and it may be necessary to use very large doses.

Chloral is perhaps the most useful at the onset, and subsequently towards evening so as to procure sleep, fifteen to twenty grains being a safe dose for an adult. Its great danger is heart paralysis, from which the use of bromide of potassium is comparatively free. The latter may be given up to four or six drachms daily. Tobacco-smoking helps to allay spasm in some cases.

Eserine has been used in daily amounts of one-fourth or one-third of a grain, curare one to three grains. Opium was formerly given in heroic doses, but it may entirely fail to allay the spasm.

As far as our present knowledge goes, perhaps the best treatment is the very free use of the bromide, chloral being cautiously employed as a hypnotic. Every effort should be made to sustain the patient's strength, and quinine is useful.

Since it has been shown that cocaine restrains reflex action it has been advised in the treatment of this disease.

XI. ERYSIPELAS.

JOHN DUNCAN.

Definition.—There is much difference of opinion concerning the proper application of the word erysipelas. If we define it as a contagious dermatitis, always beginning at a point and extending therefrom, we shall exclude on the one hand the varieties of erythema, because they are not contagious and do not spread from the centre, and on the other diffuse cellulitis which, although spreading and contagious, is not a dermatitis. I believe that we shall find that pathologically and etiologically these exclusions are justifiable.

Varieties.—Erysipelas is best divided into the simple and the phlegmonous.

Symptoms.—*Simple erysipelas* first shows itself as a rose-red patch. From the initial spot it spreads outwards with a sharply-defined border, and with a rapidity which varies not only in different cases, but also in one individual at different parts of the same circumference. There is palpable swelling all over from infiltration of the skin, and inflammatory exudation into the subcutaneous cellular tissue. This is very marked where the textures are loose. The eyelids, for example, may become so swollen, even in a few hours, as to produce complete closure and temporary loss of sight. At the point of acme, that is, behind the spreading margin, vesicles are apt to appear, and speedily become purulent. Behind the point of acme again the redness begins to fade, and it does so even while the periphery is advancing. When the morbid process as a whole is approaching its termination the red edge loses its definition, the vesicles dry up, and new ones do not form, the skin becomes less tense, desquamation occurs, and not infrequently residual abscesses are left where the swelling has been greatest.

Feverish prodromata are generally described. No doubt the temperature may rise often abruptly and even with a rigor before the local redness is very manifest. The intensity of the fever, however, and its duration, vary precisely with the severity of the dermatitis, and the rapidity with which it spreads, and defervescence especially responds with great exactitude to the cessation of local extension.

Inflammation occurs in the associated lymphatic vessels and glands, and here again the tenderness and swelling may sometimes be detected before the erysipelatous blush is visible.

The duration of the disease is very variable. It may fade away in a day or two, but, on the other hand, I have witnessed a case in which from a vaccine vesicle on the arm it radiated, by daily extension, for four weeks to the tips of the fingers on both sides, and downwards as far as the buttocks, but curiously enough without attacking the head or face. It occasionally happens that a second wave of dermatitis passes over the same parts before or soon after the first has passed away.

If it be uncomplicated, erysipelas is attended by little risk to the patient. But several dangerous complications may arise. When it attacks the head, meningeal and cerebral congestion may lead to a fatal result. Albuminuria is not very uncommon. Bronchitis, pneumonia, diarrhœa, peritonitis, now and again arise, and a very severe form of sore throat has been a special characteristic of some American epidemics.

Phlegmonous erysipelas differs from the simple form in the greater intensity of the inflammation.

The cellular tissue becomes rapidly infiltrated with pus, and sloughing destruction, both of it and of the superjacent skin, is not infrequent. Naturally, the constitutional symptoms are also more severe, and death may be due to asthenia or to the attendant complications, which are more frequent and fatal than in the simple variety.

Diagnosis.—There is usually little difficulty in the diagnosis of erysipelas, but the various forms of dermatitis, in which redness is a prominent symptom, have been confounded with it. In acute necrosis, when the bone is superficial, and especially in the tibia, the cutaneous redness has been so mistaken. A generalised eczema has been dignified by the name of "Universal Erysipelas." "Erratic Erysipelas," in which a blush appears now on one part of the body, now on another, and "Metastatic Erysipelas," are really forms of blood poisoning or nerve disturbance which ought to be classed in some cases with septic poisoning, in others with erythema nodosum. So far as local characters are concerned, the spreading tendency and sharp margin of erysipelas are its most important diagnostic features.

Etiology.—It may now, I think, be definitely accepted that erysipelas results from the inoculation of a micrococcus. The arguments in favour of its microbic origin are at all events very strong.

Although many writers have regarded it as a blood disease, and have laid stress on its resemblance to zymotic and other generalised affections, there has always been a consensus of opinion among the more acute and thoughtful observers that it is produced by a poison entering the body from without. English surgeons especially have insisted on its communicability from one patient to another, and have collected an overwhelming mass of testimony on the point. It is certainly not yet definitely ascertained what the necessary conditions are. No one can doubt that it may be carried by unclean dressings, or by the clothes, instruments, or fingers of attendants; but it is not yet quite clear whether or not it may be conveyed through the air. It is contagious; it is probably also infectious.

Erysipelas has a very distinct tendency to endemic prevalence in hospitals and such like localities, as well as to occur in the *clientèle* of individual practitioners.

Hirsch has accumulated a mass of evidence to show that it sometimes assumes the character of an epidemic, but the favouring conditions elude search, and erysipelas cannot be regarded as typically an epidemic disease.

A special feature of erysipelas is its proneness to attack the wounded. From the earliest times it has been divided into the *traumatic* and the *idiopathic.* It assuredly appears frequently without apparent breach of surface, and it is held by some that the liability of the wounded arises not so much from direct infection at the wound as in consequence of a constitutional predisposition produced by the fact of being wounded. But, on the other hand, many consider that the idiopathic variety is rather apparent than real; that a breach of surface at the point of origin, however small, always exists, and it is to be noted that this form has a distinct predilection for parts such as the nose and ear, where minute scratches are peculiarly frequent. It is yet undecided which view, if either, is correct, and perhaps the question is incapable of solution. But the fact that the traumatic form begins at the wound and spreads outwards seems to imply that the materies morbi has been there received.

Indirect support to the proposition that it is a disease of microbic origin is given by its diminished prevalence under the antiseptic treatment of wounds. It does occur, notwithstanding antiseptic dressings; but so does ordinary putrefaction, and this occasional incidence must be regarded as due to faulty manipulation or faulty method. I believe that I have seen cases in which a pure cultivation has been introduced (erysipelas without putrescence), and if that be so, it is evident that the same rigid precautions ought to be taken to protect a septic as an aseptic wound. That one poison has already been introduced is not a reason for permitting the entrance of another.

A curious observation may sometimes be made if the dressing be carbolised gauze. The local redness is often little visible until it reaches the margin of the dressing.

But the most important proof that erysipelas is due to the introduction of a micrococcus is afforded by the experiments of Koch, Fehleisen, and others. The former showed that by inoculating a pure cultivation of micrococci from erysipelas a similar disease may be produced in certain animals. Fehleisen, with the view of curing certain forms of skin disease, has similarly inoculated human beings on many occasions. He has never failed to produce a disease which in general and local characters is precisely like erysipelas.

But we have by no means exhausted the etiology of the disease when we conclude that it is due to a micrococcus. A special soil is required for its growth. It is very definitely limited to certain animals. In the human subject there are very various degrees of susceptibility. I suppose that very few, if any, would resist direct inoculation in quantity. But both in normal and diseased conditions predisposition is manifest. Some people, apparently in perfect health, are singularly prone to be attacked. A nurse in my wards invariably suffered whenever she was brought much in contact with it. Among abnormal states, Bright's disease and diabetes render their victims very susceptible to erysipelas. Many other diseases, of which imperfect elimination is a leading feature, have a like effect. A medical friend, who has often had erysipelas, looks upon it as a disease of the liver, because he is not affected by exposure to it unless his liver be out of order. Gout, alcoholism, intemperance in food, the effects of a chill, all predispose to it, and locally a wound in a dropsical limb is peculiarly liable to a severe form.

As with all similar diseases, it is yet undetermined whether the germ may originate *de novo*, or is maintained only by perpetual succession from one human body to another. Does it breed only in the body, or may it grow outside? The facts favour the latter hypothesis, and associate it rather with the malarious than the purely zymotic group. If so, it remains to be ascertained with what conditions it is associated. Undoubtedly, imperfect ventilation, over-crowding, and bad drainage, predispose, but that may, of course, be merely because the conveyance is thereby rendered more easy, or the health of the patient deteriorated.

Treatment.—The treatment of the disease may be divided into the general and the local.

It may safely be said that our first efforts should be directed, considering the predisposing causes, to stimulation of the emunctories. A mercurial, followed by a gentle saline, is usually beneficial. The diet should be such as throws little strain on the digestion, but of good nutritive value. Stimulation is useful only when adynamic symptoms are very marked. It cannot be too strongly insisted upon that uncomplicated erysipelas tends to spontaneous cure, and that heroic remedies are out of place.

Several medicines have been vaunted as specifics.

It is very doubtful, however, whether any of them are reliable, for the uncertain duration, and the usually favourable termination of the disease, are serious sources of fallacy. The tincture of the muriate of iron is the only drug which may possibly have some value. It is certainly useless unless its administration be begun very early in the course of the disease, precisely, therefore, at the time when it is impossible to say whether the attack will last one day or ten. Moreover, even when given early and in large doses, it may fail. In a case of simple erysipelas I continued to give twenty drops of the tincture every three hours, from the first day of illness to the end of the third week; but the disease steadily progressed till it ended naturally in recovery. Nevertheless, I am impressed with the belief that if given early, and in large doses, it tends, on the whole, to shorten the attack.

Locally, also, an immense variety of applications have been used, but I know of none which are trustworthy to arrest the progress of the disease. If the surgeon, on that account, determines to adopt a purely expectant treatment, he will render the patient as comfortable as may be by dusting with some dry powder, by covering with cotton wool, or by smearing thickly either with white paint or with oxide of zinc ointment, to which a little glycerine has been added to keep it soft. He will choose one or other, very much according to the locality attacked.

I am not, however, prepared to assert that the local specifics which have been recommended are absolutely inoperative, and it is noteworthy that those that have enjoyed most favour are germicide. Sulphate of iron, in ointment and lotion, has been much used; but, although Velpeau estimated it highly, it has now fallen into disfavour. Some have strongly advised to paint, in front of the advancing disease, a broad barrier with a stick of nitrate of silver, or with its solution in flexile collodion. If the erysipelas be recent, or advancing slowly, it is difficult to determine how far the cure is due to the treatment. If, on the other hand, it be of some days' standing, and spreading quickly, with a sharp margin, I have seen it hesitate, but never fail to pass the barrier.

The impression made on my mind by the use of iodine is distinctly more favourable. When the Edinburgh tincture is painted freely all over, I have, in many cases, been much struck by the immediate fall of temperature and cessation of the dermatitis. But I have seen it fail, notwithstanding most energetic use, and it also appears to be chiefly beneficent in the early stages of erysipelas.

Residual abscesses should be opened with antiseptic precautions.

In the phlegmonous variety, free incisions must be made in such a way as to secure perfect drainage. The bleeding is pretty free, and should be stopped at once by pressure and cold, that the patient's general debility may not be increased. In this form it may sometimes be necessary to stimulate freely.

XII. PYÆMIA AND SEPTICÆMIA.

C. Mansell Moullin.

Traumatic fever, or wound fever, is the name given to the pyrexia that often follows the infliction of even subcutaneous and aseptic injuries. Mental disturbance may account for it in part, but the chief cause is the entrance into the circulation of material that has been in some way changed, so as to act topically upon the nerve centres controlling animal heat. At least everything that tends to prevent decomposition on the surface of a wound tends also to prevent the occurrence of this fever, though it may not be able to abolish it absolutely.

Septicæmia or septic intoxication (for they are held by Burdon Sanderson to be the same thing) is the most intense form of this fever. It is a process of poisoning such as might arise from the injection of any noxious chemical substance into the blood, and is caused by the absorption of the products of putrefaction. What the nature of the poison may be (or of the poisons, for it by no means follows that there is only one) is not certainly known. Probably it is an alkaloid, and it may belong to the ptomaines, substances produced during decomposition, and existing under certain conditions in saliva, urine, and the contents of the alimentary canal. The poison is not a germ or living organism, though very likely it is the product of one. It requires no incubation time for its development, does not increase or multiply in the animal body, and the symptoms follow at once with a severity proportionate to its amount and the rapidity of absorption, whence the danger of wounds exposing large and active absorbing surfaces such as the peritoneum.

Traumatic fever and septicæmia, therefore, differ from each other only in degree, and if living organisms are the ultimate source of the poison, apparently they can only live on the surface of the wound; or, at least, if they do ever penetrate deeper, and enter the blood stream, they are rendered incapable of producing further symptoms.

Pyæmia is distinguished from both of these, either by the presence in the blood of living germs capable of conveying infection, or by certain local and constitutional phenomena, which, from the peculiarity of their character, and the regularity of their appearance, are considered distinctive. The cases, however, included under this term form a very badly defined group, the symptoms that occur in each not being nearly so well marked or so uniform in character as they are in both the previous disorders.

In a considerable proportion of them the two great distinguishing features are both present, but it often happens that one or the other fails. Sometimes there is no evidence of the existence of a germ, but, in spite of this, the case is considered to be pyæmic if embolic abscesses, rigors, diffuse suppuration, and the like are present, or even if the temperature is exceedingly irregular with occasional profuse sweats, coming on without apparent cause. On the other hand, the local troubles may be entirely wanting, so that as in anthrax or malignant pustule, the only visible lesion is the presence in the blood of myriads of living organisms. This is known as septic infection, distinguished on the one hand from the other forms of blood poisoning by the absence of local mischief, and on the other from septic intoxication and traumatic fever by the infective living organisms circulating in the blood.

Contrary to what takes place in septicæmia, if the germ that causes septic infection gains access to the blood, it multiplies therein to such a degree that the most minute trace inoculated in another animal acts with equal, some even think with intensified vigour. Moreover, there must be a period of incubation for the development of the germ, and the size of the wound and extent of the absorbing surface are of no consequence. Just as with the bacillus of anthrax, the germ that is the cause of septic infection can enter through the smallest scratch, and only needs time to develop its full energy. The disorder, too, is a progressive one, terminated only by the vital strength of patient or of the germ. One or other must give way, and it rarely happens that the patient is able to outlive the poison and survive, even if no visceral complication set in.

The other forms of blood poisoning are not so clearly defined. Many of the cases, especially after operations about the urinary tract, are purely local at first, and only affect the constitution as a consequence of this. The great characteristic is the presence of metastatic or secondary deposits accompanied by rigors and high fever; and these symptoms are so peculiar that whether an infective organism is present or not, they are considered sufficient to stamp the disorder as pyæmia.

Much of the confusion with regard to the nomenclature of cases of blood poisoning has arisen from the fact that in other countries, and by some writers in England, the above definition, especially so far as concerns septicæmia, is not admitted. Septicæmia has for them no relation whatever, either to septic intoxication or traumatic fever; it is an acute febrile disorder, characterised by the presence in the blood of infective organisms, and not attended by any local complications, such as embolisms and the like, so that it corresponds much more closely with septic infection than with anything else.

It rarely happens that these different forms of blood poisoning are found sharply defined from each other. Often it is impossible to say whether it is severe traumatic fever or a slight attack of septicæmia. So with pyæmia and septicæmia; the former has been thought to bear the same relation to suppurative fever that the latter does to traumatic, but the only evidence in favour of this is that as a rule they occur about the same period. Sometimes a case which begins as the one ends as the other, and it is not possible to say whether one has turned into the other; or whether the two poisons were not introduced together, the symptoms due to each taking different lengths of time to develop; or whether indeed it may not be that germs, capable of causing pyæmia, are much more commonly distributed than is generally supposed, only that they are unable to develop so long as the person continues healthy, lying as it were latent until the power of resistance has been overcome by injury, traumatic fever, septicæmia, or some other agency.

It is not advisable to regard the presence of metastatic abscesses as an absolute distinction between pyæmia and septicæmia. It is true they very rarely occur in the latter, and are very common in the former, but exceptions to this rule are far too frequent to allow it to be regarded as definite. Many cases of pyæmia run their course so rapidly that the fatal end comes before there has been time for them to develop, and when they are present they are really due to accessory causes not essential to the disease. They are rather complications, but so peculiar in their clinical and pathological features, and so frequently present, that the conception of blood poisoning is always associated with them.

Septicæmia, septic intoxication, and septic infection, all imply the existence of putrefaction, but there are certain facts which suggest the idea that this (understanding by it decomposition attended with the evolution of stinking and offensive gases) is not absolutely essential. It is not contended for a moment that the conditions favouring putrefactive germs do not also favour, and favour to a very high degree, the development of these poisons, merely that the name is misleading by implying that it is impossible for the one to occur without the other. There is no doubt, for example, that the intensely virulent poison present in the bodies of those who have died of puerperal peritonitis actually diminishes in activity as putrefaction advances, and it sometimes happens, both with septic infection and septic intoxication, that there is no evidence of putrefaction anywhere in the neighbourhood of the wound. Indeed, in the former of these, not only may putrefaction be dispensed with, but so may even the wound itself, for acute suppurative periostitis and ulcerative endocarditis very often end fatally from pyæmia, the blood being loaded with bacteria without there ever having been a wound at all. The only explanation for this is that the germs must enter in some other way through the respiratory or the alimentary tract, and that as it is possible for them to do so always if they can do so once, either the tissues, so long as they are healthy, must be able to prevent their development (which Burdon Sanderson has shown to be possible), or else that when one of these disorders is present, even though there is no putrefaction, they find an appropriate nidus for their development, one without which they cannot grow. Anthrax is now no longer called indefinitely septicæmia, because it is recognised that the bacillus differs in its character from the ordinary one present in putrefaction; so with the septicæmia of Davaine, which is due to the presence of germs differing both from the bacterium termo and the equally common form of bacillus. Putrefaction may favour the growth of these, almost certainly that of the latter, but it is very doubtful if it is essential. It may be the same with other forms of septic infection characterised by the presence of organisms circulating in the blood ; there may be germs closely resembling the common ones (perhaps varieties of them), existing under the same condition, but only capable of developing their full energy when circumstances are favourable, when, for example, they meet with an organism already rendered unhealthy by traumatic fever, intemperance, or other cause, and these germs may be the cause of septic infection, whether putrefaction is present or not. However this may be, there is no question that though putrefaction is not absolutely essential, the germs of septic infection and those of putrefaction occur together with such frequency that the presence of the one is a very strong indication of the likelihood of the other.

The pathological appearances in a fatal case of septicæmia are not very distinctive. The blood is described as being " tarry " in appearance, and either does not coagulate at all, or else forms a loose, soft black clot, which readily breaks down again. The lining of the vessels and the endocardium is often stained by deposits of blood, which can be washed off with water, and sometimes by actual ecchymoses, which also occur on the serous surfaces of the viscera, and at times in their interior, due to the disintegration of the blood corpuscles and the soaking through of the colouring matter. The liver and lungs, especially the posterior margins of the latter, are softened and congested so that they tear readily, and this is still more marked in the case of the spleen. On section, the structure of the viscera, and particularly of the kidneys, is confused and blurred, owing to the changes in the epithelium, and the alimentary canal is frequently in a condition of acute catarrh, though this is much better marked in the case of the artificially produced septicæmia of animals than in man. It is rare to find large purulent deposits, though there may be a considerable excess of acrid fluid in the serous sacs. Decomposition, especially if the wound is foul and gangrenous, seems to spread from it all over the body, almost before the patient's death.

In **pyæmia** there are the same general appearances, but owing to the more gradual action of the poison they are not so well defined. The blood often shows important changes; it generally coagulates exceedingly well, even when the disease is far advanced. There is a steady increase in the number of white corpuscles during the whole period in fatal cases, while the red ones show signs of undergoing disintegration, breaking up into molecules, and forming masses without showing the least tendency to run together into rouleaux.

In addition, however, there are nearly always present in pyæmic cases, when they last sufficiently long, local collections of pus, of which some are very characteristic. No part of the body is exempt; all the serous cavities, or the subcutaneous tissue in any part, may be distended with a thin intensely irritating purulent fluid. The joints and tendon sheaths, especially the larger ones, and those most used, may be full of oily pus, greenish-yellow in colour, from the hæmoglobin of broken-down corpuscles. One only may be affected, or there may be many, even when it has not been suspected during life. If it is quite recent the synovial sac and the cartilages show no great change, but after a short time the capsule becomes soft and yielding, so that the pus bursts into the cellular spaces round the joint, the cartilage becomes eroded and falls off in flakes, and the articulation is hopelessly disorganised. In many places the conneetive tissue between the museles, or in other parts of the body, seems as if it literally melted down into pus, leaving irregularly-shaped spaees full of tissue débris and broken-down blood elot, without wall or limit of any kind. The skin is somctimes deeply stained, or it may show purpurie patehes, the remains of areas of livid red visible during life, and even boils and small abscesses.

Every organ in the body, but espeeially the liver, lungs, and spleen, may be riddled with abscesses of all sizes, many conical in shape, with their bases towards the surface, and arranged as if they radiated from one eentre, others diffuse and spreading in all directions, wherever the eonneetive tissue is most abundant and loosest in texture. Even the eye and the brain do not eseape.

Many of these are due to thrombosis and embolism. It was for a long time supposed that pus either found its way from the outside into veins, or else was secreted by their living membrane, and then was carried off by the blood and deposited in different organs. It was pointed out in favour of this, that secondary deposits are especially eommon after injuries involving veins, partieularly if, as in the ease of bones, the walls are rigid, so that they eannot collapse when cut aeross, and that pyæmia rarely oecurs when wounds heal by the first intention, while it is eommon after diffuse suppuration, when the walls of the veins are thickened, swollen, and bathed in pus, and their eavity filled with a broken-down, semifluid elot, at first sight looking like pus. It was this material, in general prevented from entering the eireulation by a proteeting coagulum, that was sometimes earried off and formed metastatic deposits.

Now, it is quite true that these are the conditions under whieh pyæmia does oceur, but in the first place these metastases are true abscesses, not deposits of pus; and secondly, healthy pus when injected into veins will not give rise to them. It will give rise to pyæmia, and, if injected into the cellular tissue, to a local abscess, but not to secondary ones of this character. Experiments soon showed that if it was allowed to decompose first, the results were altogether different. Evidently some change was induced in it, as in every other organic substance, by putrefaction causing it to act as the most virulent poison. Then it was ascertained that a substance could be extracted from putrefying material capable of producing the symptoms of septic intoxication, if injected into the blood, the severity being proportionate to the amount. But if, instead of this chemical poison, the minutest trace of the living organisms present under such conditions found its way in, after the lapse of a short time all the symptoms of septic infection set in with rapidly increasing intensity, until the blood itself became so full of germs that the most minute portion was capable of communicating the disease.

If under these circumstances the patient live sufficiently long, local secondary or metastatic deposits almost always make their appearance. The blood itself, and the lining membrane of the vessels, are so profoundly modified, that here and there, behind the valves, or in the capillaries, coagula make their appearance, and spread from one vein to another, until large areas of venous channels are blocked by thrombi, or a big vein, such as the femoral, is completely occluded. Where the nutrition of the tissues has been in any way interfered with this is especially liable to happen, therefore; particularly in the region of the wound, at the seat of old injuries, and at any spot where the most trifling hurt is sustained, the slightest bruise often leading to extensive sloughs, and the puncture of a hypodermic needle to large abscesses. The thrombus is composed mainly of coagulated blood, but includes also cells thrown off by the intima and infective germs. This readily breaks down; then fragments are swept along by the blood stream through the heart into the arteries, until, meeting with one too small to allow them to pass, they become impacted. The ultimate result of this depends on two things: (1) the freedom of the collateral circulation, and (2) the infective power of the clot, or rather of the organisms it contains.

If the embolus acts merely as a mechanical obstruction, and the arterial branch is a terminal one (that is, its area of distribution having no other supply), local anæmia and gradual degeneration ensue; but if, on the other hand, an influx of blood from collateral sources can take place, either it is sufficiently free to restore the circulation, so that no worse result follows than thrombosis of that small trunk, or if not abundant enough for this, the blood pours in from all sides without strength of current enough to force its way out until this portion of tissue is so congested as to be almost solid. This is called hæmorrhagic infarction, and is common in the lungs and spleen, but never occurs in the liver or subcutaneous tissues.

In pyæmia the germ is always infective, so that suppuration inevitably follows. If infarction has taken place previously, a deep red zone of congestion is found surrounding a central spot in which gangrene rather than suppuration seems to have occurred; if it has not, there are merely extensive tracts of pus and sloughs without limits of any kind.

This will only account for a few of the secondary abscesses in pyæmia. Suppuration in the serous cavities is frequently caused by small embolic abscesses in the walls of the viscera, but it is often independent of these, and it is decidedly rare to find any trace of embolism in connection with purulent synovitis.

Slight injuries, such as sprains, unnoticed at the time, will account for a few (for in pyæmia the most trivial injury turns to suppuration), and capillary thrombosis over extensive tracts of tissue for many more; but it occasionally happens that the mischief is strictly confined to one class of organs, such as, for example, the articulations. It seems as if pyæmia, like rheumatism or syphilis, has a special predilection for certain tissues, and that this differs in different examples, for sometimes, especially in chronic cases, the abscesses are limited to the subcutaneous tissue, or the joints alone, as in the puerperal form, and sometimes the pleura and pericardium are attacked out of all proportion, as when pyæmia follows otitis and acute suppurative periostitis.

It may be noted that when no embolic abscesses develop in the course of a case, but merely diffuse suppurations in the cellular tissue or serous spaces, it is sometimes called in distinction pyæmia simplex.

The symptoms of septicæmia are those of the most intense fever. It usually commences within a very few days, within twenty-four hours in the case of abdominal operations, where there is a large accumulation of poisonous material lying in a cavity with great power of absorption. Or it may come on later, as the traumatic fever is subsiding, and it may either attain its height at once, or continue to increase in intensity as more and more of the poison is absorbed.

There is sometimes a rigor or an attack of vomiting at the commencement, but this is rarely repeated unless fresh doses of the poison are absorbed. More often there is a rapid rise of temperature to 105° or 106°, without any apparent reason, while the face becomes flushed, the pulse rapid and feeble, and the respiration hurried and shallow. The extremities are cold, while the trunk is burning hot; the tongue is dry and brown, and the lips and teeth covered with sordes. Diarrhœa with blood-stained stools is common in artifically produced septicæmia, but not so frequent in man. As the temperature rises delirium comes on, and in three or four days, in an acute case, exhaustion and heart failure end the scene. In other cases the symptoms assume a typhoid character from the first, the patient sinking rapidly in a state of complete prostration, with low muttering delirium, and a pulse that is almost imperceptible from the first. This is especially common when, after the infliction of an extensive wound, putrefaction sets in, and spreads upwards along the limb, simulating traumatic gangrene. The skin is red and œdematous along the flexor surface; round the margin of the wound itself it may be black and almost cold; higher up there is extreme tenderness along the lymphatics and over the nearest glands, while the subcutaneous tissue may already be crepitant with the gases of putrefaction. The patient lies in a state of complete lethargy, conscious, but taking no notice of anything around; the face rapidly assumes the hippocratic type; the tongue is parched, and has numerous painful cracks, and the skin is covered with a cold and clammy sweat. The temperature is generally low, sometimes even subnormal; but the hurried, shallow respiration and quick, fluttering pulse, show there is no hope to be derived from this. Diarrhœa, with intensely offensive stools, may come on; so may bronchitis and pneumonia, hastening the fatal end. The skin may remain natural in appearance, or it gradually assumes an icteric tint, from the destruction of the blood corpuscles. The main symptoms point to the complete prostration of the whole nervous system, spreading gradually from the higher centres to those controlling organic life.

The symptoms of pyæmia.—Pyæmia, on the other hand, may set in at any period. No wound is exempt, although it seldom attacks one that is granulating, unless the protecting layer is bruised or broken down. Cavities in which there is a state of constant tension owing to imperfect drainage, and wounds of bone where the veins, from the rigidity of their walls, are unable to collapse, suffer more than any others. Sometimes the wound is healing well at the time of the outbreak, but more often it is foul and sloughy, with an offensive or ichorous discharge. The most liable of all are compound fractures in which suppuration has set in. Detached fragments of bone become necrosed, and, moving about with every motion of the limb, lacerate the tissues in all directions, and break down the granulations; the inflammation spreads farther and farther along the periosteum and the medullary canal, more and more pus is thrown out, and the danger of absorption increased tenfold by its impeded exit and its rapid decomposition.

Pyæmia may commence insidiously, nothing but an indefinable sense of anxiety about the patient, a conviction that something is very seriously wrong, arousing suspicion; or with a sudden and severe rigor, the temperature rising five or six degrees in a few minutes, and falling again in the space of half an hour, with profuse perspiration, and a sense of the most complete exhaustion. Rigors are seldom absent altogether; if they should be, it will generally be found either that the thermometer undergoes sudden and extreme variations, or that profuse perspirations set in from time to time without apparent reason. There may be only one, or there may be any number; sometimes they are so regular as to simulate ague, or there may be several in one day and none in the course of the following week. It does not seem clear that there is any connection between them and the formation of metastatic deposits.

The general symptoms are those common to all forms of blood poisoning, only they are seldom so acute as in septicæmia. In addition, there are those dependent on the formation of the local abscesses, varying according to their number, size, and situation. The expression of the face is always one of peculiar anxiety and apprehension, becoming much more marked as each rigor comes on. Emaciation is extraordinarily rapid, the tissues of the body seeming to melt away, not only in the face, so that the eyes sink deeply into their sockets, but all over. Fugitive erythema, not bright red, but rather livid, is often seen here and there, sometimes indicating the formation of a purulent deposit beneath; boils, vesicles, purpuric patches, and even pustules, are none of them uncommon. The skin and conjunctivæ are often distinctly icteric, even when there are no secondary deposits in the liver; herpes breaks out round the mouth after the rigors, and leaves painful cracks and fissures; the tongue is red and smooth at first, later covered with brown crusts, and the teeth with sordes, while aphthous patches and ulceration over the fauces render deglutition more and more difficult. The breath, and sometimes the whole body, exhales often a peculiar sickening mawkish odour.

Delirium is rarely absent, worse at night and as the temperature rises. At first the patient can be roused, but rarely so as to give coherent answers; soon it becomes low and muttering, passing on into coma. One very peculiar and characteristic feature is cutaneous tenderness, the slightest touch on certain parts of the body giving rise to screams of intense agony. Often suppurating foci are found corresponding to these points after death.

Diarrhœa, vomiting, and epistaxis are sometimes present; the urine is scanty and high-coloured, with traces of albumen in it as the temperature rises.

Pleurisy, pericarditis, pneumonia, or purulent synovitis may develop without the least warning at any moment. In many cases pus makes its appearance in an articulation so quickly and with so little warning that it is necessary to examine them thoroughly every day. In the earlier period of the disease the effusion may disappear again to a great extent, but this rarely happens after it has lasted any length of time.

In pyæmia suppuration may occur anywhere, so that the local symptoms are varied in the extreme. Those due to the constitutional disturbance, the rigors, temperature, sweats, odour of the breath, peculiar icteric tint of face, speedy emaciation, and extreme tenderness of skin, are much more characteristic. The presence of any one of these is sufficient to excite the gravest suspicion.

Treatment.—So far as concerns pyæmia and septic infection, the treatment, when once they have fully developed, is almost hopeless; the various symptoms may be met, and that is all. In septicæmia, on the other hand, where the poison is a chemical one, and severe in proportion to its amount, something may occasionally be done by checking the absorption of more, and assisting the elimination of that which has already entered. But this is exceptional. Prevention is, in consequence, all the more imperative, first to prevent the poison developing, no matter what its nature may be; secondly, to prevent its being absorbed if by any chance it should be present.

The surroundings of the patient and the state of the wound are the first consideration. Perfect cleanliness, in the chemical sense of the word, must be insisted on in everything; the air should be pure and sufficient in quantity. Nothing predisposes more than over-crowding to that malaise, loss of appetite, and feverishness, which, so to speak, pave the way for blood poisoning, especially if there are many open wounds. Ventilation must be thorough.

Bed, bedding, instruments, and appliances that come in contact with the sick patient should be scrupulously clean. The hands should be thoroughly disinfected before coming near a wound, and ward sponges should never be allowed, unless they are kept in a solution of some strong disinfectant. It is probable that the actual vehicle of the poison is more often some material object, such as these, than the air, although cases of blood poisoning have been traced directly to recent cleaning operations in which old collections of dust were set free.

It is still more important to prevent anything like decomposition or impurity in the neighbourhood of a wound. For this purpose many disinfectants are made use of, and each has its own particular advocates. Wounds that heal by the first intention almost invariably escape, and when they are granulating they enjoy almost equal immunity.

Unhappily, in many instances there is neither time nor opportunity to effect any change in the condition of the patient. It is a well-known fact that people in what is called a robust state of health, taking a large amount of exercise and consuming much food, are not nearly such good subjects for operation as those who may have been long bed-ridden. Laid up suddenly and without preparation, they become feverish of themselves. The state of the bowels, the condition of the urine, the activity of the liver, even the mental condition of the patient, are all to be taken into consideration.

Supposing, in spite of everything, decomposition has set in, much may be done by way of checking absorption. It has already been mentioned that wounds covered with healthy granulations are rarely attacked, the current is towards the surface. But this no longer holds good if the granulations are in the least bruised or injured, whence the necessity of perfect rest. Every movement in a wound inflicts some injury, and opens up a way for blood poisoning.

Drainage is the most effectual method for preventing absorption. Every wound should be so arranged that the effusion should be able to escape at once either from some dependent opening or through properly adapted tubes; and it must always be remembered that cavities will empty themselves much more readily from two openings than from one. If wounds do not unite at once by the first intention, lymph is thrown out and accumulates if no proper exit is provided, until a state of tension and fever is set up, independent altogether of decomposition. Where this is present in addition, everything is as favourable to the development of blood poisoning as it possibly can be.

It occasionally happens, in cases of septicæmia, that benefit is derived from remedies acting on the skin and the digestive tract. Whether the result is due to a more rapid elimination (such as, perhaps, in certain cases occurs naturally) or not is uncertain, but it must not be forgotten that diarrhœa once set up may speedily prove fatal from exhaustion.

Abscesses should be opened at once under antiseptic precautions, whether they occur in joints or cellular tissue. Nothing is to be gained by leaving them, and it will often be found that they are much more extensive than they appear to be. Especially in puerperal pyæmia, joints that are treated in this way, and carefully arranged on splints, frequently recover with a surprising amount of movement. It is just possible that, in a few cases of septicæmia, amputation of a limb higher up may save life, if, for example, it is clearly due to traumatic gangrene; but such must be altogether exceptional.

It has been imagined that quinine and sulphite of soda, if given in sufficiently large quantity, would act directly as germicides, and so cut short the disease at its root; but the evidence on which this view rests is not satisfactory. The former is, however, of great use in small doses as a tonic, and in larger ones for the purpose of reducing the temperature, for which also salicylic acid may be employed.

For the rest, everything depends on the patient's strength, which must be husbanded and supported in every way. Provided no internal visceral complications set in, the ultimate result will turn on this. It is certain that sometimes it is possible to live down the germ of malignant pustule and recover, and so it may be with pyæmia. Change of scene and change of air, especially if it has developed from over-crowding; the most nutritious food that can be digested, and a due supply of stimulants, attention in this particular being paid especially to the condition of the heart, are the most important. Musk, ammonia, ether, and camphor, may be of service in exceptional cases

XIII. TRAUMATIC FEVER.

FREDERIC S. EVE.

Traumatic or **wound fever** are terms applied to the febrile disturbance following a wound or other injury, including simple fractures and subcutaneous wounds.

It was described by Hunter and Travers as symptomatic fever; but to later writers, and especially to Billroth and Lucas-Championnière, our more intimate knowledge of its course and causes are due.

Course.—In the course of a fully-developed case of traumatic fever two stages may be recognised, a primary simple traumatic or wound fever, and a secondary or inflammatory fever. The secondary fever, being of the nature of a complication, is often absent; but it may occur without any antecedent primary fever, it may be separated from the latter by a distinct interval of remission of temperature, or the one may pass insensibly into the other. Indeed, the onset and progress of cases of traumatic fever, owing to causes connected with the wound and to individual peculiarities, are subject to so many variations, that it is hardly possible to select for description a type having a definite value as a standard for comparison.

The height and duration of the fever bears an important, but not a direct and unvarying relation, to the extent and severity of the wound, for traumatic fever is, at times, almost or entirely absent after the severest injuries (for example, compound fractures and amputations), and may be severe after trifling injuries. In twenty of seventy-seven cases of injuries and operations observed by Billroth, and in thirty-five of one hundred and eight by Pick (recorded respectively in

1862 and 1868), no rise of temperature was perceptible. Practical surgeons will require no statistics to convince them, that in wounds treated with modern precautions against decomposition and accumulation of secretions, this proportion has considerably increased, and that the severity of traumatic fever has much diminished; this fact was early recognised by Volkmann, who characterised the slight degree of fever and of constitutional disturbance accompanying the healing of wounds treated with Listerian precaution, as aseptic traumatic fever.

Primary wound fever.—The rise of temperature usually begins immediately after the injury, constituting the reaction from the shock; but it may be

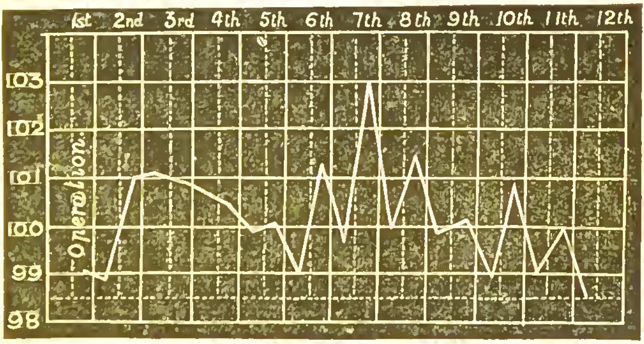


Fig. 4.—Chart of Traumatic Fever, showing Primary Wound Fever and Secondary Fever, after the Removal of a Lipoma.

preceded by a fall of temperature or delayed until the second, or even the third day, counting the day of the operation as the first. The fever lasts from two to six days. The rise takes place rapidly, and reaches its highest point or fastigium usually on the second, but sometimes on the third or fourth day. In those cases in which the fastigium is reached more slowly the rise is interrupted by recurring remissions;

otherwise it is continuous. In uncomplicated cases the highest point is rarely above 100° to 101° Fahr., but may reach 103° or 104° Fahr. The fall or defervescence is, in an equal number of cases, sudden or gradual, in other words by crisis or lysis. The fall in the former is continuous; in the latter is broken by evening exacerbations.

Mr. Pick has observed that the highest temperature is often noticed twelve hours before the establishment of suppuration, when a sudden fall occurs.

Symptoms.—The general symptoms of traumatic fever are similar to those of any simple febrile disturbance, and are generally proportionate to the degree of fever; they consist in derangements of the circulatory, digestive, and depurative organs, and of the sensorium. The pulse is full and frequent; its chart tracing runs parallel with that of the temperature, except, occasionally, in old people, when it falls relatively much below the temperature. The tongue is furred and there is loss of appetite, thirst and constipation, severe cases being marked by dryness of the tongue and, perhaps, retching and vomiting. The patient suffers with headache, malaise, or a sense of illness; broken rest or sleeplessness sometimes culminate in mental excitement and, rarely, delirium. The skin is dry.

The excretion of urea is increased, and is most abundant a day or two after the highest temperature. Rigors are very rarely or never observed, but a feeling of chilliness may be experienced.

Coincidently with the development of traumatic fever, the wounded or injured part shows evidences of reaction, such as heat, pain, swelling, and sometimes tension.

Secondary or inflammatory fever.—In favourable cases the defervescence of the primary fever is succeeded by an uninterrupted convalescence; but if from any cause the secretions of the wound are retained, or if undue inflammation is excited in it or in adjacent parts, a sudden or more gradual rise of temperature occurs, accompanied by chilliness, and in the more severe cases by a rigor; an exacerbation of the general symptoms of fever follows. The secondary fever may be directly continuous, without a break, with the primary fever; and in such cases in which the traumatic fever is prolonged beyond the eighth day, or in cases in which at any time the temperature rises after it has distinctly fallen, local inflammatory processes will be generally found at the seat of the wound.

Inflammatory fever usually appears on the sixth to the ninth days, but may occur as early as the fourth day or at any subsequent period until the healing of the wound is completed. If slight it may last only one to two days, while in other cases it may be continuous, passing into the condition of hectic or suppurative fever; or it may be the precursor of one of the complications of wounds to be presently mentioned. Its origin must necessarily be sought in any of the causes exciting undue inflammation in wounds, of which the chief are: the retention of secretions in deep, devious, or ill-drained wounds, tensions or ulceration about sutures, the irritation of foreign bodies or ligatures, the presence of sloughs of skin, tendons, and fascia, and, in wounds of certain localities, the retention of urine or fæcal matter. Lastly, in wounds adjacent to or involving the large serous cavities, localised inflammation may be set up in the lining membranes.

Causes modifying traumatic fever.—These may be divided into local, and general or constitutional. Of the local conditions, the nature, extent, and severity of the injury exercises an influence only secondary to that of the general condition of the wound. After contused, and the nearly allied gun-shot wounds, traumatic fever is prolonged and severe. It would, however, not be anticipated that wounds inflicted by the cautery are rapidly followed by a well-marked fever prolonged until the eschar has separated.

The general conditions must be here very briefly considered. In the aged, traumatic fever is slowly developed, and of little intensity. Excessive loss of blood is followed by a rapidly occurring and high degree of reaction, while after severe shock, as observed by Mr. Pick, the fever is ill-defined and remittent. In those already suffering with fever from chronic suppurative diseases, traumatic fever is quickly excited and unusually severe, although exceptions to this statement are found in cases in which the removal of a source of irritation is followed by a marked general improvement.

The influence of visceral disease must also be alluded to ; it is often grievously manifest when operations are performed in those suffering from somewhat advanced phthisis, by an unusual severity of the fever, with a rapid extension of the pulmonary disease. The observations of Billroth would show that albuminuria, whether from granular or lardaceous disease of the kidneys, exercises but little influence on the traumatic fever itself, although it carries with it a serious liability to the various complications of wounds. The subjects of rheumatism and syphilis are liable, as Verneuil has shown, to outbreaks of these diseases after injuries or operations, with a consequent modification in the course of the temperature. Alcoholism also has an unfavourable effect.

Complications.—Traumatic fever may be complicated by, or may pass into, any of the various diseases complicating wounds, as septicæmia, pyæmia, erysipelas, gangrene, etc., of which the onset may be diagnosed by the course of the temperature and the general symptoms. Its relations with septicæmia especially are undoubtedly intimate, and, in fact, its severer forms have been described as septic traumatic fever, being indistinguishable from the less acute forms of blood poisoning.

Pathology.—The pathology of traumatic fever has, since the time of Hunter, proved a fruitful source of discussion. Two theories find supporters. The one seeks to explain the production of fever by supposing that the direct irritation of nerves at the seat of a wound excites a disturbance in the centre for regulating the heat of the body situated in the medulla oblongata. The other refers it to the toxic effects produced by the absorption of the secretions of a wound acting through the same apparatus. The fact that the rise of temperature often immediately succeeds the fall accompanying shock, and other circumstances, lend some support to the former, but the weight of evidence appears to be in favour of the latter theory. It has been experimentally proved that the perfectly fresh and undecomposed secretion flowing from a wound during the first twenty-four or twenty-eight hours is capable of producing intense fever. Further, that the serum expressed from fresh blood clot is also pyrogenous, the febrile action being, probably, in great measure due to the fibrin ferment, which is set free by the decomposition of the white blood corpuscles. It is, therefore, highly probable that primary wound fever is chiefly due to the absorption into the circulation of the undecomposed sanious serum, together with the blood and lymph exuded from freshly made wounds; and as the same materials are effused in simple fractures, subcutaneous wounds, and contusions, the same theory will hold good for them.

The secondary fever is likewise produced by the absorption of the secretions of inflamed wounds, which, although undecomposed, possess, in addition to an intense febrile action, a locally irritating effect.

Treatment.—The preventive measures, as well as the treatment of traumatic fever, are comprised in the general management of wounds, especially as regards drainage, cleanliness, and the avoidance of tension. Sources of irritation and of pain should, if possible, be removed. Measures calculated to relieve the general symptoms of fever should be employed, constipation being remedied by the exhibition of saline aperients, and excessive fever controlled by quinine, and, if necessary, by sponging with tepid water or the bath.

XIV. HECTIC OR SUPPURATIVE FEVER.

Frederic S. Eve.

Hectic, a continuous or abiding fever as its name implies, is the constitutional disturbance accompanying long-continued suppuration and other inflammatory diseases.

In surgical practice it is only too frequently observed in those exhausted by suppuration from large abscess cavities, or in the subjects of chronic suppurative diseases of joints and bones; it occurs also as the result of injuries, such as compound fractures, or of operations, and, in fact, of any surgical disease entailing suppuration with exhaustion. But *profuse* suppuration, although a most important element, is not essential to its production, for in medical practice it is a conspicuous symptom of phthisis, even in cases which have not progressed to *extensive* softening and suppuration of the pulmonary tissue. Empyæma, hepatic abscess, and tuberculous disease of the kidneys may be named among other diseases in which it is commonly observed.

Symptoms.—The gradual onset of hectic fever progresses step by step with increasing weakness and emaciation. The fever is characterised by elevation of temperature to 100° or 102° Fahr. in the evening, with a remission in the morning to or even below the normal standard; in rare instances a rise occurs more than once in the twenty-four hours. The pulse is feeble, and quickened to 100, 120, or above. The healthful appearance of some hectic patients, with their lustrous eyes, dilated pupils, and delicately rose-tinted cheeks, is no less charming than delusive. The digestive organs, at first unimpaired, are soon affected; the appetite becomes precarious, the tongue red at the tip and edges, and slight constipation gives place to frequent attacks of profuse and obstinate diarrhœa. During the day, the skin, especially that of the hands and feet, is dry, but, with the decline of temperature towards the early morning, the patient breaks out into a profuse perspiration, which is followed by intense languor and exhaustion. Increased quantities of urea and salts are excreted by the kidneys. The intellect remains clear to the last. The emaciation becomes extreme; the mouth and tongue are covered with aphthous patches; and exhaustion with diarrhœa terminate the case.

Lardaceous disease is a common concomitant of hectic, for the conditions of their development are closely allied.

Etiology and pathology.—Hectic fever is generally referred to the absorption of pus which has undergone fermentative changes; but, by some, exhaustion is looked upon as the chief factor in its causation. The former theory is supported by the following facts: that it does not occur until an abscess is opened, and that it is prevented or checked by adequate drainage, and methods of dressing which prevent decomposition. There is probably truth in both theories; exhaustion doubtless exercising a powerful influence on the centres in the medulla immediately regulating the vital functions, and rendering them more sensitive to the pyrogenous action of purulent matters absorbed into the circulation. The cyclical character of the fever in hectic cannot, however, be taken as proof of its purely nervous origin, for other fevers due to specific causes, as malaria, show an even more regular periodicity.

Treatment.—The local treatment must necessarily vary with the nature of the disease. The accumulation and decomposition of pus in abscess cavities should be prevented by drainage, posture, and antiseptics. Parts affected with local suppurative diseases, when a cure is otherwise despaired of, should, if possible, be removed without delay. A nutritious diet frequently administered, and stimulants in moderate amounts, are indicated. Special symptoms will require appropriate treatment. To check diarrhœa, pulv. kino co., sulphuric acid, and chlorodyne are respectively the most useful remedies. Excessive perspiration is controlled by the administration of strychnia and of atropine. Quinine may be given as a tonic and febrifuge.

XV. GUN-SHOT WOUNDS.

JAMES CANTLIE.

GUN-SHOT INJURIES.

THE term *gun-shot injury* is one which serves as the generic name for wounds inflicted by missiles from cannon, rifles, shot-guns, and pistols. The weapons have changed from smooth-bored to rifled, and the bullets from spherical to conical, but the wound inflicted is called gun-shot, whatever be the nature of the weapon, or the kind or course of the bullet. Shell wounds alone are spoken of by a separate name.

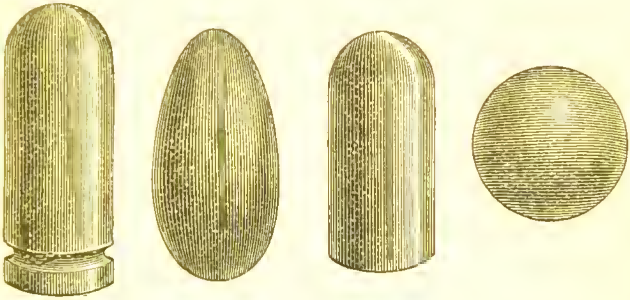
Missiles.—The various missiles in use are: (1) "Shot," as distinct from bullets: one of the most common causes, in civil life, of the specific wounds of which we are speaking. The size of the particles may vary from the smallest "sparrow hail" to the largest "buckshot." They are usually numbered as No. 1, No. 2, and so on, up to No. 12, No. 1 indicating the largest, and No. 12 the smallest of the series. The weight of the particles in No. 12 shot is from one-sixth to one-fifth of a grain, nearly three thousand shot being present in one ounce. The weight of a buckshot, No. 1, is 133 grains.

(2) Pistol bullets, varying in size from about one-fifth inch (·22) to half inch (·50) in diameter; the weight may be as little as 25 grains, or as much as a rifle bullet, 350 grains.

(3) The round leaden shot used in the smooth-bored gun: a thing of the past (Fig. 5; 4). The bullets varied much in weight and shape, as every man could cast his own; their weight varied as much as from three-quarters of an ounce to one and a half ounces.

(4) The rifle bullet, the destructive missile of

modern warfare. It is of a more or less conical shape; it varies in weight from 315 grains (the Swiss army bullet), to 480 grains (the British regulation bullet). The diameter of the Swiss bullet at the base is ·41



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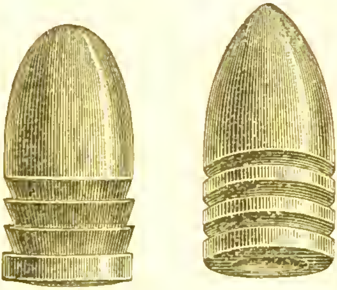

5. 6.

Fig. 5.—Bullets.

1. Martini-Henry; 2. needle gun; 3. chassepot; 4. musket; 5. Snider; 6. Enfield.

inch, the British bullet ·45 inch. Lead is the base of all bullets, but the Americans and British add tin to harden the lead (Fig. 5).

(5) Bullets for machine guns, such as the Gatling, Gardner, Hotchkiss, mitrailleuse, and Nordenfelt; these throw bullets varying between one and three-quarter ounces to half a pound in weight.

(6) Shot for field guns and siege guns, which throw

either solid, grape, case, or canister shot, some of the canister containing as many as 280 small iron balls. In Fig. 5 the chief forms of bullet are shown in their natural size.

The *distance* at which such missiles are effective increases almost from year to year, and the velocity and trajectile of the bullet varies according to the rifle used. The Martini-Henry rifle can send a bullet three miles, and the guns of H.M.S. "Conqueror" a ball nine inches in diameter, eleven miles.

The apertures of entrance and exit.—In the old days of spherical bullet wounds the apertures of entrance and exit elicited much attention. With the conical bullet and its high rate of velocity the differences between the apertures have ceased to be of any marked character. In the case of the spherical bullet the aperture of entrance was small, circular, ecchymosed, and with slightly inverted edges; that of exit was larger, irregular, lacerated, and with everted edges. The rifle bullet at its entrance causes a larger wound than the spherical, and this wound is often lacerated, and of a linear or crucial shape. Hence it is well-nigh impossible to tell the apertures one from another. A bullet may cause multiple wounds, as when firing in the lying or kneeling position a bullet may penetrate the left fore-arm, the left arm, and finally the chest; and so with the lower limb in the kneeling position.

Two or more bullets may have entered the body at about the same moment, as in volley firing, and it is extremely difficult to ascertain whether it was or was not one and the same bullet which caused the various wounds. Deflection of a bullet in its track will also still further cause perplexity; and although the spherical bullet is more easily deviated by a bone, tendon, or blood-vessel, a conical rifle bullet is liable to the same deviation to some extent.

The **immediate effects** of gun-shot wounds depend upon the part of the body hit. The most frequent causes of sudden death on the field of battle are wounds of the brain, or one of the large blood-vessels, be they arteries or veins.

Primary hæmorrhage is one of the most common causes of sudden death; wounds of the aorta, the iliacs, the femorals, the subclavian, the axillary, and the carotid arteries, when the bleeding cannot be or is not restrained, will lead to the belief that the soldier was shot dead. It is astonishing, however, to note from injuries of what magnitude to blood-vessels recovery is possible. This is to be accounted for by the lacerating nature of the missile, causing the contraction and retraction of the vascular walls necessary to the formation of a coagulum and the restraint of hæmorrhage. A gush of blood may occur when a vessel is severed, and the hæmorrhage thereafter cease. So often is this the case, that a popular belief exists that bullet wounds do not bleed. The same may, however, be said of other lacerated wounds, and a bullet wound, after all, is a lacerated and contused wound, caused by a missile travelling at a high rate of speed.

Shock, as after all injuries of any magnitude, is a concomitant of gun-shot injury. In warfare the previous excitement, in suicidal cases the mental tension, and in homicidal and accidental cases the sudden dread of death, all contribute to account for the intensity of the shock after gun-shot injuries. Most marked is the shock after abdominal wounds. This admits of ready explanation, since it is through the effects on the sympathetic system, more especially on the solar plexus and its large offshoots, that the phenomena of shock arise.

Pain.—In the heat of battle the soldier is frequently unconscious of being wounded, and it may be only from the fact that blood is found issuing from some part, or that a limb becomes useless, that the fact is brought home to the wounded man. Likewise in civil life the knowledge of being hit by a bullet need not be communicated by the pain, as frequently it is slight or altogether absent. Even the severance of a large nerve may cause little or no pain. However, after a time pain usually supervenes, and may be of an acute burning, of a dull bruised, or of a tingling character.

Tetanus is a condition which the older surgeons, especially those engaged in the Peninsular war, have impressed upon our minds as associated with wounds on the field of battle. The disease is not so frequently met with in modern warfare; in fact, it is rather a rarity. Whether this is due to the change in the character of the bullet or the peculiarity of the climate in the Spanish Peninsula, is a matter of uncertainty. Damp and chill nights following a high mid-day temperature have been regarded as possible factors in the etiology of tetanus.

The appearance of tetanus on the field of battle is speedy, compared with what we know of that disease in civil life. Should the wounded be left over night in a chill, dewy atmosphere, in tropical or subtropical regions, trismus, the precursor of tetanus, may have made its appearance, or well-developed tetanus may have come on before morning.

As in nerve lesions connected with an ordinary fracture of bone, so with bullet wounds, tetanus is more frequently met with when peripheral regions of nerves are injured, rather than when the larger trunks are divided.

The ultimate effects of gun-shot injuries which are not immediately fatal will depend upon how soon the wounded man is brought under treatment, the nature of the tissue or organ wounded, the climate in which he is campaigning, the skill with which he is treated, and the hygienic conditions by which he is surrounded. If allowed to lie on the field of battle, the wounded man may die of secondary hæmorrhage, shock, cold, exhaustion, or tetanus.

The *effects* of a gun-shot wound vary with the nature of the tissue injured.

The skin when injured may be (1) grazed only. This may be followed by the severe prickling and burning pain, characteristic of a fall, causing skin scraping, and termed "brush burn." The pain is greatest when the slight erythema, which invariably follows, supervenes. (2) The skin may be contused, and may subsequently slough. (3) The elasticity of the skin may be so great when stretched, as in the kneeling position, that a bullet enters by almost an incised wound. (4) A large shot or piece of shot may hit the skin, reduce the bones, muscles, etc., beneath it to a pulp, and may never penetrate.

The fasciæ, superficial and deep, behave somewhat differently. The superficial fascia may have blood extravasated into it far and wide around the bullet track; the deep fascia, on the other hand, is usually clean cut, and its fibres, separated for the moment, partially cover the track, obscure the path of the bullet and prevent subsequent drainage.

Muscles are usually extensively injured. (1) A bullet may pass clean through a muscle, making a round hole in it. (2) A muscle may be bruised and lacerated, and blood infiltrated into its sheath from end to end. (3) When a muscle is completely divided the ends retract. (4) When a limb is torn off by a large shot or shell, the muscles, as in other lacerated wounds, do not retract.

Tendons of muscles are more likely to escape injury than almost any other structure; from the fact that they are round, movable, and tough, they frequently deflect a bullet.

Bones are usually (1) comminuted; (2) they may be simply penetrated; (3) they may be penetrated, contused, and split longitudinally; or (4) a bullet may be lodged in a bone for an indefinite period.

Diagnosis of gun-shot wounds in general. —At first sight it would seem, although it were easy enough to recognise the fact, that a bullet had penetrated the body and lodged there, but this is not borne out in practice.

1. In the first place the missile may have caused a bullet wound in the skin, but may not have entered the body; this peculiar state is accounted for by the fact, that the clothing may have been carried by a slowly travelling bullet into the skin, and that on removing the clothing to search for the body wound the bullet is dragged out.

2. Multiple wounds in the body may have been caused by one or more bullets. The possibility of a bullet entering and re-entering the body during particular positions has been already dealt with.

3. The deflection of a bullet is apt to give rise to confusion as regards its course and position. The rule is that a conical rifle bullet goes straight through, but it is a mistake to assume that such is always the case. The deflection possible with spherical bullets and pistol bullets in general, is a condition which must always be borne in mind when treating such injuries.

Fasciæ, bones, tendons, and arteries, all tend to cause deflection, especially with spherical, but also, though much less frequently, with conical bullets. Hence, in examining for a bullet attend to the following points: (1) Get the history of the case if possible; this is especially necessary in suicidal or accidental injuries. (2) Examine the hole in the clothing, with the object of ascertaining whether it was completely perforated, whether a piece is torn out, or if the clothing around is stained by the explosion of the gunpowder, as would happen at close quarters or in suicidal cases. (3) Place the body and limbs, if there is any doubt about the bullet track, in as nearly as possible the imagined position at the time of being hit. Especially is this essential with multiple wounds before it can be known whether one or more bullets caused the wounds. Even then the difficulty is not got over, as the fact of deflection must be reckoned upon. That a bullet is in the wound is to be judged by the fact that no aperture of exit exists, that the track is fairly deep; but the crucial test is recognition of the bullet by the finger or a probe. The introduction of a probe is uncertain and unsafe; the finger is true and devoid of danger.

The different appliances used are:

1. Nélaton's bullet probe. This is a probe tipped with "biscuit" porcelain, which, when it touches the leaden bullet, gains and retains a bluish stain. A piece of clay pipe stem may serve as an improvised means to the same end.

2. Sayer's vertebrated probe was devised as a means whereby the probe might follow the windings or unevenness of a bullet track.

3. Electric probes, whereby a galvanometer is deflected when the bullet is touched may and have proved useful in the search for a bullet in some obscure cases.

4. The injection of a weak solution of an acid, capable of dissolving, and hence becoming stained by, the presence of lead is recommended; this device might be of service in some instances.

5. Cutting forceps, whereby a piece of the hard substance felt in a wound may be bitten off and examined is an unwise method of procedure.

Examinations for the purpose of diagnosis must be made as soon after the infliction of the injury as possible, but any attempt to push the finger in, say twelve hours after, is attended by much pain. The finger is the means of diagnosis to be relied upon, and with the modern bullet and its large aperture of entrance, especially when a bony surface is beneath the skin of the part wounded, there is usually no difficulty of introduction. Probing wounds, especially in the flurry of a battle-field, ought to be strictly forbidden.

The prognosis of gun-shot wounds is so dependent upon the nature of each case that it is impossible to lay down definite rules or even suggestions. The prognosis, to be of any value, is so bound up with the direction for treatment to be given on the first sight of the case that all consideration of the sort will be deferred until the treatment is discussed.

Treatment of gun-shot injuries. — The general principles of treatment on the field are as follows:

1. Combat the shock by ordinary restoratives.

2. Stop hæmorrhage by digital and then by instrumental compression. A tourniquet may be improvised out of a handkerchief, bandage, brace, or such article, and a bayonet or sword-scabbard passed through the knot and twisted. A knot on the handkerchief, or a pad of some kind placed over the course of the artery above the wound, will aid in the more speedy and certain arrest of hæmorrhage. Esmarch's elastic tourniquet is also effective and easily applied. If necessity arise the artery may be tied on the field of battle.

3. Allay pain, if possible, by position, by correcting a faulty posture, or by the administration of an opiate.

4. The further treatment to be adopted is, when

it can be done, as follows: Syringe out the part with carbolic lotion (1 in 20) or chloride of zinc lotion (20 gr. to the ounce); cover the part with dry cotton wool, which is absorbent and antisepticised with a non-volatile material such as salicylic acid, carbolic acid, iodoform, or boracic acid. Burdeleben's antiseptic tampon and Burrough's sponge are specially prepared applications, which may be clapped on a wound and held on by bandages and straps; and, if necessary, the whole limb, if that is the part wounded, may be rendered immovable by being fixed to a rifle on the field, or by plaster of Paris bandages on the field or at the dressing station or field hospital. The further treatment of gun-shot injuries is to be undertaken at the dressing station, field or base hospital. At the dressing station an artery may be ligatured, and the tourniquet may be removed from the limb; should no antiseptic dressing be available, the bullet wound may be explored; but if possible it is better to delay that until the field hospital or even the base hospital is reached.

The exploration of the wound and extraction of the bullet.—As already mentioned, the exploration is to be done by the finger, and it must be done by a clean finger, *i.e.* one duly antisepticised. Probes are unsafe and uncertain. It may be necessary, when thorough exploration is advisable, to enlarge the wound.

Remove the bullet or other foreign body as soon as it is discovered. For this purpose many different forms of forceps have been devised, but the ordinary dressing forceps is practically the instrument mostly used. Coxeter's bullet extracter is not by any means a perfect instrument. A fenestrated artery forceps with bulging blades, sharply hooked at the point, is at times successful where a dressing forceps fails. The bullet is extracted, as is any foreign substance, in the way which best suits particular cases, therefore no definite rule can be laid down for the manipulation.

Subsequent progress of gun-shot wounds. —When no antiseptic treatment is available for the treatment of the wound, the following train of symptoms usually develop. No sooner have the effects of shock gone by than reaction of an acute kind sets in, and the temperature rises to, it may be, 104° by the second day. The pain and suffering from the tension of the parts is usually very great upon the third day, by which time suppuration may have set in. When free drainage is provided the patient has a chance of recovery, as shown by the subsidence of the inflammatory fever ; but frequently secondary hæmorrhage, erysipelas, gangrene, septicæmia, or pyæmia supervene and carry off the patient.

Secondary hæmorrhage may come on during the passage of the wounded soldier from the front to the rear, owing to the jolting of a rough road, etc. Especially when a bone is broken is its jagged end likely to rub a hole in the vessel in contact with it. If a bullet is left in a wound and in contact with an artery, the vessel wall may either ulcerate or slough, and death may result by a succession of hæmorrhages in the former case, or by a sudden gush in the latter. The usual causes of secondary hæmorrhage are of course present factors in gun-shot injuries, such as a bad ligature, a badly or a too hastily applied ligature, neglecting a fair-sized vessel which afterwards bleeds, tying an artery too near to the origin of a large branch, the supervention of erysipelas, scurvy, typhus, hospital gangrene, pyæmia, non-union of the flaps, hæmophilia, diarrhœa, etc.

Septicæmia, pyæmia, hospital gangrene, gangrene, and erysipelas are diseases and conditions which are one and all associated with gun-shot wounds in both civil and military practice. The nature of the wound: a long sinus with bruised and lacerated walls, which, when reactionary circulation is established, swell up and prevent exit of exudation matters. Besides, in military surgery there is, and ever will be, a great danger of overcrowding in the field or base hospital. The wounded of an army in a hostile country can only be carried along one route and to one focus. Especially if that focus be a civil hospital, a church, or some large building, is it apt to get over-crowded.

Amputation for gun-shot injury is required:

(*a*) When, in addition to fracture, fissure, or comminution of a bone, or penetration of a joint, the main vessels or nerves of the limb are injured or destroyed.

(*b*) When a cannon shot scoops out a large piece of the soft tissues and of the bone of a limb.

(*c*) When part of a limb is carried away.

(*d*) When acute osteo-myelitis sets in.

(*e*) When gangrene results from local injuries.

(*f*) In some cases of tetanus.

(*g*) In cases of secondary hæmorrhage which defies other means of cure.

The *time* at which amputation is demanded varies with circumstances and conditions.

1. When no antiseptic dressing is available in the form of antisepticised cotton wool, gauze, etc., the limb should be amputated as the intensity of the shock is wearing off. Ether is the preferable anæsthetic during such amputations.

2. When an antiseptic dressing can be provided, and the wound is of such a nature that it is possible to convey the patient from the dressing station to the field hospital, or, still better, to the base hospital, if even that be a three days' journey, it is better to do so before amputating. The danger is that inflammatory reaction should come on during the transmission,

when any operation is to be regarded as certain to cause death.

Operations before inflammation has appeared are called *primary*; operations performed during the inflammatory period are called *intermediary*.

When the symptoms of acute inflammatory fever are over and suppuration is fairly established, amputations (*secondary* amputations) may be performed with better hopes of success than during the inflammatory stage. The rule is, unless the bone is splintered and fissured, to amputate immediately above the injury in the soft parts; but a stump of bone which is fissured will only lead to the formation of fat emboli, osteo-myelitis, osteo-phlebitis, and pyæmia. Amputate through a joint where possible instead of through the lower end of the bone above; so, on the other hand, amputate below a joint if even two inches of bone can be saved thereby.

Injuries to bones form a very special part of military surgery. When a bone is *contused*, the immediate treatment is rest and the application of cold; and subsequently incisions may have to be made to release inflammatory effusion or relieve tension. Should the bone, after all, necrose, it must be dealt with in the ordinary way.

Fracture of bones.—Bullets give rise to such special forms of fractures, that almost a new nomenclature is required to express the different kinds.

Almost all gun-shot fractures are compound; but the bone may be fissured, comminuted, splintered, penetrated, perforated, or resected, *i.e.* a large piece may be carried away.

The immediate treatment is that the bone of the fractured limb be rendered immovable as quickly as possible. When the wounded soldier is taken to the field hospital, the wound is to be washed out with an antiseptic lotion, and search made for the bullet by an aseptic finger. The bullet, bits of cloth, loose splinters of bone, or whatever else there may be in the wound, should if possible be withdrawn. The following plan is to be pursued unless amputation is called for. Wash the part clean, make counter-openings where necessary and insert drainage tubes ; cover the part with antiseptic cotton wool, either salicylic, carbolised, iodoform, etc. ; apply a plaster of Paris bandage over all, including the joints above and below the fractured bone ; cut a hole opposite the seat of the drainage tubes or wounds in the plaster of Paris bandage. To prevent the bandage cracking, owing to the weakening of its circumference by the cutting of holes, a splint of some kind should be applied over the plaster of Paris bandage.

Gun-shot injuries of joints.—Since the practice of the application of antiseptic dressing has been introduced on the field of battle, the surgery of the joints has been totally revolutionised. When the surgeon first sees a wound in the neighbourhood of a joint, whether it penetrate the joint or not, he ought to inspect the wound carefully, syringe it out or wash its surface with chloride of zinc lotion (20 grains to the ounce), apply absorbent disinfectant cotton wool, and cover the whole with a bandage. At the same time he should apply a long splint (a rifle) to the lower limb, or an angular splint to the upper limb, to render them immovable.

When the patient reaches the dressing station, the joint ought to be enveloped in plaster of Paris, and (when that is dry) he should be moved to the field or base hospital. There the wound should be examined, amputation performed if necessary, or the bullet or piece of clothing extracted if it can be found ; counter-openings should be made and drainage tubes freely introduced if an attempt is to be made to save it. A covering of antiseptic cotton wool or gauze should be applied and enveloped in plaster of Paris, trap-doors should be cut in the bandage opposite the wound, and a light splint should be applied to keep the joints above and below quiet and prevent the plaster cracking during transmission.

A limb is condemned for amputation when the joint is opened, the soft tissues destroyed around it, and especially if the bones are fissured to a great extent and the main vessels or nerves of the part are destroyed.

Excision, however, presents a very favourable means of treatment for injured joints short of those requiring amputation. Excision may be performed before the shock has worn off (*primary excision*); during reactionary inflammation (*intermediary excision*); or after suppuration has existed some weeks (*secondary excision*). In all averages given primary is more favourable than secondary, and secondary more favourable than intermediary.

In the joints of the upper limb primary excision is very much more favourable than in the case of the lower extremity. The following are some of the statistics collected by Otis.

After *excision of the shoulder joint* the mortality is as follows: Primary, 24; intermediary 45; secondary, 28.

After *excision of the elbow*, primary, 21; intermediary, 29; secondary, 28.

Bullet wounds of the wrist joint generally require amputation.

Bullet wounds of the hip joint are of a most fatal nature, whether treated by expectancy, excision of the splintered bone, disarticulation of the hip joint, or amputation.

It seems the safest plan to enlarge the wound and remove splinter bones; and if the patient has to be removed afterwards, to render the limb immovable.

Bullet wounds penetrating the knee joint require amputation at the lower third of the thigh when no antiseptic dressing is available. When, however, immediate antiseptic treatment can be employed as already detailed, there is good hope, according to Reyher's showing, of saving the limb and obtaining a useful joint. Bullet wounds of the ankle, especially when treated immediately by antiseptic dressing, present a warrantable reason for averting amputation.

Gun-shot injuries of the head.—When the scalp alone is wounded it is to be treated as other scalp wounds; and when the bullet or bird-shot is lodged, and there is much extravasation observed, the missiles are to be left until the swelling subsides before an attempt is made to remove them. The cranial bones may be contused or fractured. When contused, an attempt to check the onset of inflammation is to be made by the application of cold to the head: either an ice bag or a coil of tubing (the mediate irrigation coil). Should symptoms of supra-cranial or subcranial collections of pus develop, the pus is to be relieved by incisions or trephining in the usual way. When the bones are fractured spiculæ must be removed from the meninges, the bone must be elevated if depressed, and the bullet must be extracted if it can be found without hunting in the brain matter. For all these plans of treatment the trephine will almost certainly be required. When the bullet has lodged about the base of the skull, as in suicidal cases, through placing the pistol muzzle in the mouth or to the ear, the situation of the bullet is usually a matter of mere conjecture. Meningitis or cerebritis following bullet injuries of the brain present very slight hopes of surgical interference being beneficial.

Gun-shot injuries of the chest.—According as bullets in this region penetrate or not, so is the danger to be ranked. Besides, the tendency for a bullet to follow a rib and emerge from the skin as though it penetrated the lung is always to be borne in mind. The parts which are wounded most readily are the ribs, the heart, the lungs, and the vessels of the chest wall and at the root of the neck. When the wound is not immediately fatal, proceed as follows: Wash the part clean, and if the wound is large enough, examine the track with a clean finger. If the bullet, button, or piece of clothing can be felt, or is found projecting beneath the skin, remove it. Stop bleeding from the internal mammary by ligaturing both ends of the severed artery. Plug the intercostal space when an intercostal artery is bleeding and cannot be readily ligatured. Do not hermetically seal the wound of aperture or exit unless severe hæmorrhage from the wound may seem to demand it. Subsequent tappings for blood, pus, pleuritic effusion, or pneumo-thorax may be required. The removal of a necrosed or partially severed piece of rib should be delayed as long as possible.

The general treatment of penetrating wounds of the chest is dealt with in Art. I., vol. iii.

Gun-shot injuries of the neck are especially dangerous, as likely to wound the trachea, œsophagus, carotid arteries, internal jugular veins, or the vagus nerve. Wounds of the trachea are to be closed immediately, unless bruising of the tissues around forbids, when a tracheotomy tube must be worn. The carotid arteries must be tied, the internal jugular vein (as are other large veins) may be either digitally compressed or ligatured. Wound of the œsophagus is recognised by the direction of the track of the bullet, and by the escape of food through the wound in the neck. Should the trachea and œsophagus be both wounded, food would escape into the trachea, causing suffocation. The patient should be fed by a long tube passed into the stomach.

Gun-shot injuries of the abdomen are, as may be expected, of an extremely fatal character, the danger depending upon possible wound of the viscera. It is often impossible to diagnose the character of the visceral injury, unless the damaged part protrude through the wound. In any case of penetrating wound there will be collapse, and in wounds of the liver and spleen evidences of severe intraperitoneal hæmorrhage. When the stomach has been perforated some of its contents may escape from the parietal wound, and there may be hemitemesis. When the bowel is wounded intestinal matters may in like manner escape. In both of these injuries peritonitis supervenes early should the patient survive the stage of collapse.

Perforation of the bladder will be attended by symptoms akin to those associated with rupture of that organ. (*See* Art. XIII., vol. iii.) A bullet has, however, lodged in the bladder, and has given little trouble until it became the nucleus for a calculus.

Wounds of the kidney and of the ascending and descending colon need not prove fatal if, as is often the case, the non-peritoneal surfaces of those viscera are the seat of the lesion.

The treatment of non-penetrating wounds presents nothing peculiar, but the treatment of perforating wounds involves many points of an exceedingly complicated character. In all cases wash the wound and remove foreign matter; do not use the probe, but the finger, and that very gently, wherewith to examine the wound. The treatment, up to quite recently, was simply to apply a wet compress and a bandage over the part, at the same time exhibiting opium largely. Since Listerism has been introduced, one is justified in opening the abdomen in almost any case.

When the laparotomy has been performed, any vessels that may be still oozing are to be tied, and search made for the wounds made by the bullet. If the stomach be wounded the hole may be carefully closed at many points by Lembert's suture; and to better effect such closure the margins of the aperture may be excised. This measure has been carried out with success by Kocher, in a case of pistol wound of the stomach. If the intestine be wounded the hole should be closed, when possible, by Lembert's suture; but if a segment of the bowel be so damaged as to render suturing ineffectual, the injured piece may be excised and the divided ends either united at once and the abdomen closed, or an artificial anus established. This treatment was first carried into effect with a perfect result by Mr. Bull, of New York. In any case the abdominal cavity must be thoroughly washed out and cleansed. The sooner the operation is performed the better, but the onset of peritonitis should not be an absolute obstacle to the undertaking. If peritonitis should exist at the time, the cavity of the abdomen should be drained after the laparotomy.

For wounds of the liver little can be done, and in most cases the patient dies rapidly of hæmorrhage. In cases involving wound of the spleen, the propriety of at once excising the damaged organ may be raised. Splenectomy, in cases of injury exposing the spleen, has been so successful a measure that it may fairly be applied to certain selected cases of gun-shot injury, that, without some interference, would without doubt prove fatal.

Owing to the large non-peritoneal surface presented by the kidney, gun-shot wounds of that organ may be best healed by efficient drainage. The treatment of penetrating wounds of the abdomen is considered in Art. VI., vol. iii., and of wounds of the bladder in Art. XIII., vol. iii.

Sword and sabre wounds are met with in modern warfare only after a cavalry charge. The cavalry sword does its work of destruction more by its weight than its sharpness; that is, it stuns rather than cleaves the skull. The sharp sword of the Sikh, on the other hand, will cleave the skull or shave off part of the cranial or other bone in its descent. I had under my charge a soldier, the left side of whose skull was depressed *en masse*, after a cut of the cranial bones from front to back, by a long Arab sword at the battle of Tamai. Sabre cuts, being incised wounds pure and simple, require similar treatment. Antiseptic cotton wool or other dressing applied over an extensive sabre wound has, when the edges have been neatly brought into apposition, brought about union by the first intention. A piece of the scalp, with a slice of bone adherent to its inner surface, should be replaced, if the attachment of the detached piece is wide; but if not, it would be better to remove the bone and leave the scalp and periosteal coverings to close up the wound. When the abdomen or chest are wounded by a sword, the usual rules, when penetration follows from other causes, are to be observed.

Bayonet wounds are of but infrequent occurrence since the introduction of breech-loading rifles, as two bodies of men approaching each other can fire up to the last moment, and one or other side must be decimated. The bayonet causes a punctured wound, presenting three lines radiating from a centre. A leech bite resembles a bayonet in miniature. The gravity of the wound will depend upon the depth to which the bayonet is driven and the part injured. The treatment is to secure rest and good drainage. When the chest or abdomen are wounded, lay the patient upon the wounded side and keep him quiet by opiates. Should suppuration and signs of deep-seated inflammation or sloughing supervene, the wound must be enlarged and free exodus of inflammatory matters must be allowed.

Arrow wounds.—In European warfare the arrow has completely disappeared, and the only instances met with of arrow wounds, to any great extent, are in the conflicts with North American Indians. Owing to the deadly effects of such injuries it was believed that poison was frequently smeared over the arrow head; but the belief is for the most part erroneous, at any rate amongst the red Indians (Bull).

An arrow causes a punctured and incised wound; and if it has passed through the part struck, the aperture of entrance closely resembles a bullet wound, whilst its aperture of exit is more frequently linear.

Arrow wounds, like bullet or bayonet wounds, may cause instantaneous death from hæmorrhage, or injury to the cerebrum. Failing that, death may be caused by any of the secondary complications mentioned under gun-shot injuries.

Treatment.—When an arrow has passed through any part, the resulting wounds are to be treated by exactly the same methods as those given for gun-shot injuries. When an arrow is lodged, however, it requires careful and special treatment. If it is on the battle field such an injury happens, the arrow should be removed if the base has not sunk beneath the skin, as may happen when its head is caught in the cranium, tibia, or other superficial bone. When, however the arrow has disappeared beneath the skin no attempt should be made to extract it in the heat of battle, but its shaft should be cut carefully, and without wriggling, close to the skin, the wound should be covered with an antiseptic dressing, and the patient should be sent to the rear. The subsequent removal of the arrow head is essential, as it is not likely to get encapsuled as a bullet might, and consequently suppuration must result with great danger to limb and life. The first principle in the surgery of arrow wounds is, that every endeavour must be made not to separate the head from the shaft. This is so easily done that the utmost precautions in examination must be taken. In the first place, should an arrow be sunken far into, say the thigh, it is better to push it onwards and cause it to protrude beneath the skin opposite the point of its entrance ; then make a snick in the skin to allow of its exit, and breaking off the head, fix a drainage tube to the shaft and pull the shaft out, leaving the drainage tube to occupy the arrow track. The shaft of the arrow might be oiled to allow of its easier passage. When the arrow has to be removed from a bone into which it has penetrated, or where it is undesirable to push it onwards, the plan of treatment is as follows : Leave the shaft sticking in the wound, and do not attempt to pull it backwards. Along the shaft as a guide pass a probe-pointed bistoury, until the head of the weapon is reached ; then cut the soft tissues freely until it is possible for the index finger to touch the arrow head. Then pass a dressing forceps and seize the arrow head, and attempt to remove. If this is impossible, from its tight fixation in a bone, a wire may be passed around the arrow head, the wire twisted around the arrow shaft and forceps, and the three firmly grasped may be removed together. Should it be found impossible to dislodge the arrow head, the bone may be chiselled or even sawn in two, as unless removal is affected loss of limb or life must necessarily ensue. Should the abdomen be penetrated and the arrow head broken off, laparotomy presents the last chance of recovery.

XVI. BURNS AND SCALDS.

FREDERIC S. EVE.

THESE painful and often fatal injuries are the result of the application of a degree of heat to the surface which occasions either inflammation or complete disorganisation of the textures.

Local effects.—The severity of burns and scalds depends on the intensity of the heat and the duration of its application; these are necessarily closely connected with the mode of causation. Thus, an explosion of gas or of gunpowder will produce a superficial scorch, while the catching fire of clothes, from the longer continuance of the heat, a more severe burn. Scalds by hot water generally are less destructive to the tissues than burns, owing to the heat being limited to the temperature of boiling water, and to the duration of its action being shorter. But some of the most severe injuries by heat are occasioned by scalds with fluids, especially oleaginous fluids, which have a higher boiling point than water, and by burns from molten metals.

A passing allusion must be made to cases of scalds of the pharynx, occurring in children from drinking hot tea or boiling water from the spout of a kettle. The symptoms and treatment will be dealt with in another portion of this work. (*See* Art. XII., vol. ii.)

Classification.—Dupuytren's classification of burns is adopted by most writers; he divides them into six degrees, corresponding to the depth to which the effect of the application of heat extends. An appreciation of these degrees is chiefly necessary in estimating the after results of burns in regard to readiness of healing and the liability to contraction of cicatrices.

In burns of the *first degree* the skin is merely scorched by the momentary application of heat, and the only result is a reactive hyperæmia and slight swelling of the skin, with some tingling pain. Desquamation of the cuticle usually follows.

The *second degree* is characterised by the formation, immediately or a few hours after the accident, of bullæ or vesicles. A serous fluid exudes from the dilated vessels of the corium, and separates the corneous from the Malpighian layer of the epidermis; but at various points the two layers remain connected by bands of epithelium. If the serum be evacuated without destruction of the detached layer, the epidermis is quickly restored beneath it; or a crust forms and healing takes place by scabbing; otherwise a raw surface is exposed, from which a sero-purulent or purulent discharge issues. After healing, some discoloration of the surface, but no cicatrix, remains.

In burns of the *third degree*, the cuticle and part, but not the entire thickness, of the papillary layer or corium are destroyed; while the *fourth degree* differs from the third in that the whole thickness of the corium and the subcutaneous tissue are involved. In both the affected skin is tough and parchment-like, and its separation takes place by sloughing and suppuration; so that until this is accomplished it is rarely practicable to distinguish between them. The escape from destruction of some part of the thickness of the corium is, as regards the ultimate effect of the injury, of the greatest importance. For the corium contains important elements of the skin which cannot be reproduced, *i.e.* hair follicles, sudoriparous glands, and elastic tissue. These, in burns of the third degree, are restored in the cicatrix; the new formation of connective tissue being limited, its contraction is slight, and the healing process is much accelerated from the fact that islands of epithelium appear, and extend over the surface of the granulations wherever traces of the rete Malpighii, hair follicles, or sudoriparous glands remain. But sometimes, owing to the points of the papillæ being exposed, burns of the third degree are excessively painful.

Fig. 6.—Contraction of wrist after burn of the fourth degree.

Contrasted with those of the third, burns of the fourth degree are more tardy in healing, for they are covered with epithelium only by extension from their margins; the cicatricial tissue is abundant, devoid of the elements peculiar to skin, and contraction is extreme, producing often horrible distortions (Fig. 6).

In the *fifth degree* the whole thickness of the skin and some portion of the muscle is destroyed. In the *sixth* the whole thickness of a member is carbonised. Such severe injuries are rarely seen, and then, as a rule, only affecting a portion of a limb.*

It is scarcely necessary to add that the different degrees combine and pass the one into the other in the same case; in fact, that in severe burns the first three or four degrees are nearly always combined.

Billroth adopts a simpler classification of burns, founded on their immediate results, viz. hyperæmia,

* In the museum of St. Bartholomew's Hospital is the skull of a lunatic who lay for some time with his head on a fire. The greater part of the vertex exfoliated, but healing was completed (Pathological Catalogue, No. 177; 1882).

blistering, and sloughing. This classification has the defect that Dupuytren's third and fourth degrees are not separated, both being included in Billroth's third grade.

Symptoms.—The severity of the constitutional effects of burns depends on their extent rather than their depth, and is also profoundly modified by their situation and the age of the patient. An extensive burn, even of the first and second degrees, is more serious in its immediate results than a smaller although deeper burn. Burns of the chest, abdomen, head and face, are followed by much more severe symptoms than more extensive burns of the extremities; and the effects of burns of the chest are disproportionately exaggerated in young children and old people, who, as might be expected, are much the worst subjects of burns.

The constitutional effects of burns, under the influence of these chief modifying causes, range from slight passing fever to shock and collapse terminating in death within a few hours; the fatal result may be deferred for some days, being ushered in by symptoms resembling those of sepsis, or, after a long course of suffering and suppuration, may supervene with exhaustion. Again, both the course and mode of termination may be varied by complications affecting the brain, the thoracic or the abdominal viscera. The constitutional disturbance following burns has been conveniently divided by Mr. Erichsen into three stages: (1) Depression and congestion of internal organs. (2) Re-action and inflammation. (3) Suppuration and exhaustion.

1. The earliest symptoms are synonymous with those of shock; the skin is cold, the patient is repeatedly attacked with shivering, the pulse is rapid and feeble, sometimes thready, and the temperature is subnormal. The mind remains clear. Pain is severe

and of greater intensity in slighter (especially burns of the third degree) than in deeper burns; but it is nearly or quite absent in the worst cases. In children, vomiting comes on early, the vomit being sometimes bloody; in adults it is longer delayed.

There is thirst and dysphagia when the mouth and pharynx have been scorched by the flames. The urine is scanty, often albuminous, and sometimes contains blood. In many cases the patient lapses into a drowsy condition, which is followed by coma and death; in others there are restlessness, delirium, and clonic spasms, generally affecting the muscles of the back. The temperature continues subnormal to the end. Children not infrequently die within the first few hours with convulsions.

2. If life be prolonged, reaction sets in after twenty-four or forty-eight hours. The appearance of a wide-spread blush of redness, heat, and swelling (the general evidences of inflammation) of the parts around the destroyed area of skin are accompanied by a rise of temperature, and general febrile symptoms resembling those of severe traumatic fever. These symptoms are kept up by the absorption of inflammatory products during the process of separation of the sloughs, and, if decomposition be permitted to occur, may culminate in those of septic poisoning. Constipation, usually existing at the earlier part of this stage, often gives place to diarrhœa, which is sometimes profuse and exhausting. Vomiting is not uncommon, and when associated with diarrhœa and melœna, such a combination of symptoms suggests, but by no means indicates, the existence of a duodenal ulcer. An ulcer may, however, suddenly cause death, with hæmorrhage or perforation of the peritoneum, without having given rise to any symptoms by which its presence might be suspected. Pulmonary complications more often occur in this

stage; but unless pleurisy is manifested by acute pain, the symptoms are not generally well marked, although the lungs be extensively hepatised.

3. The process of separation of the sloughs is usually completed by the end of the second week, and with it the third stage of suppuration begins; it continues until the termination of the case. The wound now becomes covered with granulations, and there is a profuse secretion of pus, which, if allowed to decompose, collects and becomes absorbed, renews the fever, and exposes the patient to the danger of pyæmia.

Thoracic and abdominal complications, although less to be apprehended, are not uncommon; and attacks of diarrhœa are of frequent occurrence. Weakness is often extreme; hectic may result from the continued drain on the system, and, after a longer or shorter period, may terminate in death with exhaustion.

As convalescence advances the constitutional symptoms disappear, and the local ailment becomes that to which attention is directed.

In addition to the visceral disorders already mentioned, it must not be forgotten that burns are liable to the complications of ordinary wounds, *i.e.* tetanus, erysipelas, septicæmia, and pyæmia. Rarely hæmorrhage occurs during the separation of the sloughs.

Prognosis.—The relative importance of the extent and intensity of burns, their situation, and the age of the patient, as regards the severity of the constitutional symptoms have already been commented on; from these remarks the influence of these conditions on the prognosis of the case may be gathered. It is generally considered that recovery is impossible if one-third of the surface of the skin be involved. Next to shock, congestion and inflammation of internal organs are the commonest causes of death after burns, hence the onset of symptoms of these complications renders the prognosis exceedingly grave. Burns of the chest are liable to be followed by inflammation of its contents; of the abdomen by peritonitis, and of the scalp and face by diffuse inflammation. The longer life is prolonged the greater the chance of recovery; especially is this the case after the eighth day, before which by far the larger number of fatal cases occur.

Pathology.—The pathological changes after death from burns vary with, and may therefore be conveniently considered in relation to, the stage at which death has taken place.

In the *first stage*, congestion of the brain and its membranes, and of the thoracic and abdominal viscera (the first-named almost invariably), are found; occasionally there is serous effusion into the brain. The congestion may be the result of reflex paralysis of the vessels from shock, which is an exceedingly common cause of death in this stage. But death in many cases cannot be attributed to shock, as it occurs often after reaction has set in. Many hypotheses have been brought forward, and many experiments made, with a view to explain the rapidly fatal issue of extensive burns. Some attribute it to the immediate effect on the heart and blood-vessels, others to changes in the blood itself. The former suppose (and the supposition is supported by experiment) that when death occurs immediately after a burn, the heart is paralysed from over-heating of the blood; or, if death be somewhat delayed, that it is brought about by a reflex paralysis of the blood-vessels and lowering of the blood pressure.

The latter assert that destructive changes may be observed in the red corpuscles, by which their hæmoglobin is set free; while others deny this, but affirm that the physical condition of the blood is altered by the formation of a ferment from over-heating.

In the *second stage*, that of reaction and inflammation, the pathological appearances generally correspond to those observed after death from septic poisoning. There are congestion of the brain, of the lungs, and intestines; in a considerable proportion of cases pneumonia, pleurisy, or both, are found. It is in this stage that ulceration of the duodenum is most frequent. This lesion occurred sixteen times in 125 miscellaneous cases of Erichsen's and Holmes' combined statistics. The ulcer is, as a rule, situated immediately below the pylorus; it is indolent, with clearly cut edges; it may extend deeply into the substance of the pancreas, and perforate the peritoneum, or a large vessel, usually the pancreatico-duodenal artery or one of its branches. More than one ulcer may be present. Cicatrices of ulcers, or ulcers undergoing cicatrisation, have been observed, showing that this complication is not necessarily fatal. The tenth day is said to be that in which the ulceration commonly begins, but it has been known to occur as early as the fourth day. Duodenal ulcers may form in persons of all ages, in burns of all degrees, and in any situation. Mr. Curling supposed that the ulceration resulted from inflammation of Brunner's glands, but this theory has not been supported by later observations.*

In the *third stage*, inflammation of the lungs and pleura are relatively much more frequent than lesions of the intestine or brain. The first mentioned,

* Considering the frequency of a greater or lesser degree of septic poisoning in the second stage of burns, and that congestion of the duodenum is a common accompaniment of this condition, it seems to me not improbable that the ulcers are analogous to the "hæmorrhagic" ulcers of the stomach, and are produced by digestion of areas of mucous membrane into which blood has been effused; their usual situation close to the pylorus is favourable to this explanation.

according to Mr. Holmes, are found chiefly when the thorax is the seat of the burn.

Treatment.—This will be considered under the headings of *constitutional* and *local.*

The *constitutional treatment* should be based on general principles, and more especially directly according to such symptoms as may be most prominent in the various stages succeeding the infliction of a burn. A stimulating plan of treatment is almost invariably necessary; and depletion is rarely advisable even in the presence of inflammation of internal organs, for such complications are usually of a low and congestive character.

In the first stage the chief aim is to establish reaction and relieve pain. The former indication may be met by stimulants and warmth, the latter by a full dose of opium, which should not be withheld even in children. After extensive burns much relief is afforded and the depression is diminished by placing the patient at once in a hot bath. In the second and third stages complications must be met by appropriate remedies, and the strength may be maintained by a nutritious diet and stimulants, with ammonia and bark. Diarrhœa may be arrested by astringents and opium. Quinine may be given with advantage if the temperature be high.

In the *local treatment* of burns, the protection of, and exclusion of air from the burnt surface, and the prevention of decomposition, are the indications which should guide us in the selection of dressings. During the dressings, especially the first, the body should be exposed as little as possible, one portion being uncovered and dressed before the clothes or dressings are removed from another portion. The necessity of frequent change may be avoided by using antiseptic and absorbent materials, which seldom need renewal; and in severe cases the pain and exposure attending redressing may be much mitigated by allowing the dressings to soak off in a bath.

A convenient and soothing mode of treatment of burns of the first degree consists in dredging over the surface a thick layer of flour or starch, and, if the burn be extensive, enveloping the part in cotton wool. Lint soaked in Goulard water, or a preparation known as Carron oil, consisting of equal parts of linseed oil and lime-water, may be used with advantage if the heat and burning pain are severe.

The blisters formed in burns of the second degree should be punctured (the fluid being allowed to drain away) and the epidermis carefully preserved. Flour or Carron oil may then be applied in the manner described above, and the part enveloped in cotton wool, and bandaged. Later, oxide of zinc ointment may, if necessary, be applied.

After burns of the third and higher grades, which are followed by the separation of a slough and suppuration, a non-irritating antiseptic dressing is, in order to prevent decomposition, the chief requisite. If the burn be extensive, carbolic acid and iodoform, owing to the serious effects produced by their absorption, are unsuitable; and the harmless but efficacious antiseptics, boracic acid, salicylic acid, and eucalyptus, must be resorted to. Lint which has been soaked in a saturated solution of boracic acid, surrounded by 'salicylic wool,' is, perhaps, the most convenient dressing; boracic ointment, or eucalyptus oil in olive oil, may also be used. The direct application to the burnt surface of cotton wool or of gauze soaked in some antiseptic cannot be recommended, owing to the difficulty and pain attending their removal. Iodoform may be sprinkled over the surface if signs of decomposition appear. Billroth speaks in terms of high praise of the method of treating extensive burns by the continuous immersion of the patient in a warm bath until the sloughs have separated. This may be accomplished by means of an arrangement of a bed slung in a bath designed by Hebra.

After the separation of the sloughs and the formation of granulations the treatment resolves itself into that of an ordinary ulcer of the integuments, but due precautions against decomposition of the profuse discharge must still be maintained. An ointment of boracic acid or oxide of zinc will now promote healing. Exuberant granulations should be checked by the application of a lotion of sulphate of zinc or the solid nitrate of silver. Contraction of the wound and the repression of exuberant granulations are materially assisted by strapping judiciously applied. When the granulations are in a healthy condition, skin grafts, or larger patches of skin, should be applied, and the wound covered with oiled silk or 'protective.' Sponge grafting, which consists in laying an exceedingly thin slice of sponge over the wound, was introduced and advocated by Professor Hamilton, as a means of promoting healing and preventing contraction after deep and extensive burns. The utility of the proceeding is very questionable, for although, as originally asserted, the interstices of the sponge become filled, and the layer is finally covered with granulations, yet, in those cases which I have had the opportunity of watching, the sponge did not become absorbed, and no union took place until its particles were removed or cast off. In fact, healing was simply delayed thereby.

In the healing of burns of the fourth and of higher degrees, particularly those affecting certain regions, precautions must be taken against the occurrence of contraction. Among the sad and hideous deformities too frequently seen as the result of contraction may be mentioned the drawing of the head down upon the chest or shoulder, eversion of the lids and lower lip, binding of the arm to the side, flexion of the elbow and knee, deformities of the hands and feet with webbing, or distortion of the digits. Hence it is in deep burns of these localities that special precautions are necessary both during and after healing, for contraction continues at least a year after cicatrisation is completed. In the case of burns involving the flexures of joints, the limb may be kept straight by splints. Tension may be kept up by strapping, elastic bands, or other mechanical contrivances; and the same means are applicable after contraction has commenced. Adhesion of scars to deeper structures may be prevented by daily friction with oil, and massage is also of use in arresting the further progress of contraction.

The scar tissue sometimes becomes overgrown and forms firm, raised, pinkish nodules, with claw-like processes projecting from their sides, a condition known as false keloid.

The plastic operations appropriate to the various deformities arising from contraction will be detailed in another chapter.

Amputation of limbs or parts of limbs may, under certain circumstances, be necessary. It may be advisable, if the patient be sinking from the exhausting discharge from an extensive burn of an extremity, or if, in the progress of the case, it becomes evident that the destruction is so extensive as to render the limb useless. It may be unavoidable at first, owing to the depth to which the parts have been destroyed, or may subsequently be called for by the opening of a large joint from sloughing.

Sunstroke.—This term is applied to the peculiar and often fatal train of symptoms sometimes produced by exposure to a powerful sun. Sunstroke, except in its mildest form, is scarcely known in England, but English military surgeons have a large experience of it among troops marching in tight-fitting and heavy clothes and accoutrements under the burning rays of an Indian or tropical sun. Fatigue, exhaustion and deficiency of water are important predisposing causes.

Symptoms.—These, in the slighter cases, are intense headache, vertigo, a sense of exhaustion and faintness, and, perhaps, delirium or insensibility. There is thirst, and the skin is hot and dry.

Severe cases have been divided into three types : the *cardiac*, *cerebro-spinal*, and the *mixed*.

In the first the patient is suddenly struck down with syncope, which, not infrequently, is rapidly fatal.

In the second, with or without premonitory symptoms, the patient becomes comatose. The respiration is rapid and noisy; the pulse rapid, irregular, feeble, with tumultuous action of the heart ; and there is usually hyperpyrexia. Spasms of groups of muscles or convulsions are often observed. Death may take place in a few hours, or the symptoms may be prolonged and the case terminate in recovery; but in the latter event relapses are common.

In the *mixed* variety the symptoms are a combination of those of the first and second.

Congestion of the brain was considered as the chief cause, but latterly it has been stated that anæmia of that organ exists.

Treatment.—Cold to the head and spine, applied by means of ice bags or Leiter's coils, or cold douches, with purgatives, are the remedies generally recommended. Drink may be given freely. If syncope be a prominent symptom, alcohol, medical stimulants, and warmth to the surface are the measures to be employed.

Lightning stroke.—A person exposed to the full force of the electric current is usually killed on the spot. It is not, however, with such cases, but with injuries by lightning short of a fatal result, that we have to deal.

The effects of lightning are local and general, and the severity of each bears no relation to the other. The chief local injuries are burns, varying from slight burns of the first degree to deep wounds, and, though rarely, mutilations of limbs or of other parts, and fractures of the skull. Small perforated wounds with charred edges are occasionally produced on the legs or soles of the feet, where the current has passed from the body. Curious arborescent zigzag lines on the skin sometimes mark its course. The clothes are usually torn at the point at which the current enters; and in a remarkable case recorded by Mr. Wilks,* they were almost completely torn off, and much rent. The person is rendered at once insensible, and on recovering consciousness after a short or often considerable time, finds that he is suffering with some disturbance of the special senses, as blindness, deafness, loss of taste or smell, or with paralysis and insensibility of some part of the body, the lower extremities being more commonly affected. Sometimes there is cerebral disturbance. The paralysis usually passes off gradually, and sensibility returns; even lesions of special senses may be recovered from.

In fatal cases the rigor mortis is extreme; and the blood generally, but not invariably, remains fluid. *The treatment* consists in maintaining vitality by warmth to the surface, stimulants, and artificial respiration. Burns should be treated in the usual manner.

* *See* Trans. Clin. Soc., vol. xiii., 1880. The clothes are preserved in the museum of the Royal College of Surgeons.

XVII. TRAUMATIC DELIRIUM.

FREDERIC S. EVE.

Two distinct forms of delirium, liable to follow an injury, operation, or inflammatory disorder, have been described as the alcoholic or traumatic delirium tremens, and the inflammatory.

To these a third form, of rare but undoubted occurrence, will be mentioned under the name of nervous traumatic delirium.

Delirium tremens.—An injury in those long addicted to the abuse of alcohol (especially in the form of ardent spirits) is often followed by an attack of delirium tremens, which, in its symptoms and course, differs in no way from the disease induced spontaneously, except in so far as it may be modified by the injury itself. Among other predisposing causes, which accentuate the effect of the injury in bringing about the attacks, may be added poverty and abstinence from food, and mental anxiety.

Simple, and, in a greater degree, compound fractures, and the low forms of erysipelatous inflammation so common in drunkards, are the usual exciting causes of this form of traumatic delirium.

Symptoms.—The earlier symptoms appear within the first two days after an injury, but sometimes on the third or fourth days. Restlessness, excitability, and insomnia soon give place to delirium of a suspicious or *busy* character. The patient is haunted by the apparition of goblins, snakes, or vermin, or lives in dread of the intentions of his attendants; his muttered suspicions or loud cries render, in hospitals, isolation necessary. An imperious command or loud question will usually recall him to himself, but he immediately relapses into his former state. The general symptoms are no less characteristic. There is tremor of the hands and tongue. The stomach and bowels are deranged, and the tongue is covered with a thick creamy fur and is moist, except when asthenia exists. The skin is clammy, and freely perspiring. The pulse is quickened and small, and the temperature generally, but not invariably, slightly raised ; a sudden rise or excessive elevation of temperature are of serious import. But of all symptoms, insomnia is that which is of most importance, from its regularity, persistence and difficulty of subdual.

Pathological anatomy.—Such pathological changes as may be found in the bodies of those dying with traumatic delirium tremens are usually the results of chronic alcoholism ; thickening of the meninges, sometimes a 'watery' and contracted condition of the brain, gastric catarrh, and cirrhosis of the liver and kidneys. Hypostatic pneumonia is not uncommon.

Prognosis.—It is, as a rule, not unfavourable ; an exception must be made in the case of old people and those much broken in health by chronie alcoholism and indigence, in whom death takes place with gradual exhaustion and coma.

Treatment.—The general treatment must be regulated by a consideration of the depression of the nervous system and vitality, hence antiphlogistics are contra-indicated. The state of the digestive organs requires at the commencement a moderate dose of calomel, followed by a mixture of senna or a saline aperient. The frequent administration of light nutritious food is scarcely secondary in importance to the necessity of procuring sleep. To this end the best results may be obtained by a combination of chloral hydrate and bromide of potassium ; 15 grains of the former, and 30 grains of the latter, may be given every two hours, until sleep is produced; but the effect of the chloral must be carefully watched before the draught is repeated a third or fourth time. Should the insomnia prove unusually obstinate, Mr. Morrant Baker's* plan of administering chloroform until insensibility is produced, and following it by a subcutaneous injection of morphia, admirably effects the desired results.

Opium is generally considered inferior to chloral and bromide of potassium; it sometimes tends to increase the excitement, and is inadmissible if the delirium is acute or albuminuria exists. By those who prefer opium, the repeated hypodermic injection of morphia is the most convenient form of administration.

After sleep has been procured the delirium usually subsides, and the patient will take nourishment freely.

The important and vexed question of the giving or withholding of stimulants in delirium tremens needs some remark. Notwithstanding the urgent theoretical objections to its use as the prime cause of the disorder, expediency, and a knowledge of the depressing effects of its complete withdrawal, usually demand its moderate continuance, especially in the feeble and aged. Ale or porter, in that they contain both nourishing and stimulating properties, are the most suitable.

Severe depression and asthenia must be met by larger doses of stimulants, in the form of brandy, with ammonia and bark. If the patient be violent it is better that he should be restrained by mechanical means than by assistants. Fractured limbs should be put up in suitable splints, or, if practicable, in a plaster case, and swung from a cradle; they should on no account be strictly confined, the patient in his struggles being completely insensible to pain.

* *See* St. Bartholomew's Hospital Reports, vol. xix., p. 249; 1883.

Inflammatory traumatic delirium may be considered somewhat analogous to the delirium of acute pneumonia, typhus fever, and acute rheumatism.

It accompanies the febrile disturbance produced by the absorption of septic matter from wounds, and the symptoms associated with it are those of the lesser degrees of septicæmia, in other words, of septic traumatic fever, and the rapidly fatal forms of that disease.

The delirium is more often nocturnal, and declines with the morning defervescence of temperature; its severity varies from mild wandering of the mind to furious delirium.

Treatment must be directed to subduing fever by attention to the wound; by the application of ice to the head and the administration of antiphlogistics.

The alcoholic and inflammatory forms of delirium are occasionally combined.

Hysterical persons and the subjects of exaltation of the nervous system offer, though rarely, examples of delirium without fever after slight injuries or operations. Billroth cites the case of a healthy young man, who, after a fracture of the leg with a slight wound, exhibited delirium without fever, having much resemblance to delirium tremens, although there was no history of alcoholism. Such cases may appropriately be classed under the heading of *nervous traumatic delirium.*

XVIII. HYSTERIA.

FREDERICK TREVES.

THE term "hysteria" is applied to a functional disorder of the nervous system, to a general neurosis that is difficult to define, but that may be described, if prominence be given to one of its primary features, as a condition of increased irritability to physical and psychical stimuli. It is disease without a pathological anatomy. From the origin of the term (ὑστέρα, the womb) it is only to be inferred that the disease is much more common in women than in men, and that it is often induced by some uterine or ovarian disorder. It is probable, however, that in at least fifty per cent. of the subjects of hysteria these organs are perfectly sound. Hypochondriasis in the male is very similar to, if not identical with, hysteria in the female. Hysteria most commonly begins between the ages of fifteen and twenty. It may develop, however, at any time during the period of active adult life, and not infrequently breaks forth at the climacteric.

There is nothing distinctive about the appearance of **the hysterical woman.** She may be young or old, or plump or thin. She may be of a ruddy and cheerful countenance, or may be wan and sallow, and in a constant state of flabby woe. She may be a member of what is vaguely termed a "neurotic" family. Some of her relatives may be the subjects of epilepsy or insanity, or may be dipsomaniacs, or notoriously "nervous" individuals. She may, on the other hand, be the only individual in a family to present any nervous phenomena.

The hysterical woman is, in a definite sense, irritable. Stimuli act upon her nervous system with undue and uncertain vigour, and the effects, moreover, are apt to spread. Her emotions tend to become exuberant, to be distorted, or at least to be inconstant. Over all there is a weak mental control, a lack of attempt to limit the effects of normal stimuli; if not a constant lack, at least an occasional lack, a kind of mental ataxia. She is morbidly sensitive, and presents an extravagant consciousness of self. She is oppressed by her surroundings, and judges of circumstances by the effects they produce upon herself. There is usually some bodily ill health at the bottom of hysteria, often some uterine disturbance, more often some anæmia. The subjects are usually weak, easily tired both in brain and body, and possessed by a frame of mind that is the reverse of self-reliant.

The **symptoms** of hysteria may develop suddenly after some great grief or personal calamity. More often they appear slowly. Profound emotional disturbances do not so often appear to lead to hysteria as do petty forms of irritation that are constantly repeated. Worry, the continual dropping of water upon the mental stone, is a great cause of the hysterical state.

The symptoms of the affection cannot be dealt with in detail, and can only be briefly tabulated in this place. The features of the hysterical "fit" are familiar.

Sensory disturbances.—Hyperæsthesia, intolerance of light or of sound, intense dislike to certain odours and articles of food; neuralgia, often involving muscles, and very commonly the breast and intercostal nerves; headache, hemicrania, "clavus hystericus" (a defined gnawing pain about the top of the head, near the sagittal suture, or over one brow); abdominal pains that may be attended by symptoms imitating ulcer of stomach, peritonitis, or ovarian disease.

Anæsthesia, as shown by sensory paralysis of certain tracts of skin, and by hysterical blindness and deafness.

Motor disturbances, as illustrated by paraplegia and hemiplegia, by palsy of the bladder leading to incontinence ; of the gullet, leading to dysphagia ; of the bowels, causing tympanitis and constipation, and of the vocal cords producing aphonia. Muscular tremor, muscular spasms, contracted limbs, strabismus, etc., local or general convulsions. "Globus hystericus : " a sense as of a ball rising from the abdomen into the throat, where it appears to become impacted, a condition supposed to be due to peristaltie eontraetion of the gullet.

Vascular disturbances, as shown by tumultuous or irregular action of the heart, fainting fits, congestive headaches, flushes, extremities that may be at one time burning and at another extremely cold ; bloodlessness of eertain parts of the surface, so that a pin prick is not followed by bleeding ; disordered menstruation, irregularity in the quantity of urine excreted, ete.

The phenomena of hysteria that mostly concern surgical practice are those by which the features of certain diseases are reproduced. To these phenomena the term of **neuro-mimesis** has been applied. This mimicry of disease may be very complete. The mimicry is no doubt uneonscious, if instances of deliberate malingering be excluded, and is usually founded upon some trifling local disturbance. Dr. Weir Mitchell reports the case of an hysterical girl in whom was reproduced a mimic cerebro-spinal meningitis, after she had been fatigued by nursing two patients with the actual disease. Probably her head ached and her back ached because she was tired out, and upon the foundation of these natural symptoms were soon built up the phantom malady.

Hysterical joint.—The symptoms of acute joint disease are mimicked; the parts most commonly involved are the hip and knee, and the manifestations are often preceded by some trifling injury to the limb. The joint, to take the knee as an example, is very painful, is stiff, is becoming flexed, and cannot be moved. Examination will show that the symptoms complained of are quite out of proportion to the physical evidences of disease. The pain is "excruciating" or "agonising," yet there is no effusion into the joint and no swelling of the bones. The pain also varies, and is evidently due to an exceedingly sensitive condition of the skin. It is a surface pain and not a deeply seated one. The painful spot is commonly between the femur and tibia, and if it be cautiously approached while the patient's attention is diverted, it may often be pressed vigorously upon without producing any outcry. Interarticular pressure causes no inconvenience. If the patient's attention be absorbed, the joint may often be moved to a considerable extent, both actively and passively. Under chloroform all the stiffness at once disappears. In time some swelling may appear about the joint, but it will always be in the subcutaneous tissue, and not in the articulation. The skin will probably be cooler than normal, but fluctuations in the surface heat are often noticed, and depend upon local vaso-motor disturbances. Thus Dr. Mitchell reports a case where the surface temperature of an hysterical knee was normal in the morning, but rose in the evening to 99°, 100°, or 101°. The temperature of the other or sound knee was always normal. After long-continued disuse the muscles of the limb will waste, and the features of the real disease be even more closely imitated.

Hysterical spine.—In this condition spinal caries may be mimicked. There may be a history of some slight injury to the spine, or the back may be painful from muscular weakness, or there may be a trifling degree of lateral curvature. The mimic disease is most common at the root of the neck in the region of the vertebra prominens. Intense pain is complained of, but it is quite superficial, and pinching the skin causes more distress than pressing the bone. The patient will resent forcible moving of the part, but there is no real rigidity, no deformity, and no thickening to be made out. A jar to the column will not cause pain. In some cases there may be paraplegia, which will present the characters of the hysterical form of that affection.

Phantom tumours are produced by an abiding spasm of a muscle or part of a muscle. By the contraction of the fibres a fairly defined swelling may be produced. This is most often met with in one of the compartments of the rectus abdominis, and may be attended by some of the abdominal symptoms that are not uncommon in hysteria. Dr. Weir Mitchell gives accounts of like tumours in the calf and in the pectoral region. These swellings can be made out to be muscular; they vary in size, they are apt to disappear, and entirely vanish under an anæsthetic.

Retention or incontinence of urine in the hysterical may be recognised by the general symptoms presented by the patient, and by an absence of any of the physical conditions that could cause the symptom.

Treatment.—The general treatment of hysteria concerns the physician rather than the surgeon. It will be here sufficient to say that any probable cause for the disease should be treated, uterine troubles relieved, and anæmia and debility dealt with by the usual means. Drugs such as valerian and assafœtida are of little use, but bromide of potash is of value when there is much restlessness, and when the patient is distressed by the nerve pains.

In obstinate cases no measures succeed so well as those adopted by Dr. Weir Mitchell. 1. Perfect seclusion, so enforced that the patient is removed from all home influences, and from the attractive halo of indiscreetly sympathetic friends. 2. Perfect rest both of brain and body. 3. Such moral influences as may induce the patient to recognise the true nature of her ailment, and to aid treatment by rightly exercising again a long dormant or perverted will. 4. Passive exercise in the form of massage, or "muscle kneading." This "shampooing" of affected parts should be conducted for thirty to sixty minutes daily, and, as Dr. Mitchell expresses it, acts as an admirable "mechanical tonic." The inducent current may also be used for the same ends. In some cases of hysterical joint an immediate cure has followed a rough and sudden flexing of the stiffened limb or the application of so strong an electrical current as to cause the patient to exert all her powers to prevent a threatened renewal of the treatment.

XIX. SCROFULA AND TUBERCULOSIS.

Frederic S. Eve.

Recent advances in our knowledge of the pathology of tubercle have widely modified our views regarding the relation of the morbid conditions formerly distinguished as scrofula and tuberculosis.

Scrofula and tuberculosis.—The term scrofula was applied to certain inflammatory processes affecting the lymphatic glands, skin, mucous membranes, testes, bones, and joints, and occurring almost exclusively in children and young adults; characterised by a tendency to spread by local extension, and prone to caseous degeneration. These affections were looked upon as the manifestations of the scrofulous or strumous diathesis, which was defined as a liability to the occurrence of chronic inflammations from the slightest exciting causes, and marked by rapid cell proliferation with defective power of organisation.

The term tuberculosis was limited to the grey granulations and caseous nodules affecting the lungs and viscera and the serous membranes.

The scrofulous diathesis, it was admitted, was often inherited from tuberculous parents and was accompanied by a tendency to tuberculosis. Further, miliary tuberculosis was referred by pathologists to the local and general dissemination of caseous material, the product of scrofulous inflammation. Such, in brief, were the commonly accepted views regarding the relations of scrofula and tuberculosis, until the logical deductions of Cohnheim, soon supported by the discovery of a specific bacillus by Koch, led to the acceptation that they are pathologically identical; that both are manifestations of "a chronic and infectious parasitic disease, which is produced by a tangible organic contagium."

The evidence of their identity was accumulative; it began with the demonstration of structures considered characteristic of tubercle in scrofulous glands and other scrofulous affections; it was rendered almost conclusive by experiments showing that scrofulous products inoculated on animals produced tuberculosis; it was proved by the discovery that the tubercle bacillus is present in scrofulous affections, and that pure cultivations obtained from them do not differ in their effects from those derived from true tubercle.

Anatomy.—*Tubercle* may be regarded as the product of an irritative inflammation. In its most characteristic form it appears as semitransparent grey granulations or nodules, which are called miliary from their resemblance to millet seeds. Recent miliary tubercles are made up microscopically of a few or many submiliary nodules or rounded aggregations of cells lying in a reticulum. The cells may be, somewhat arbitrarily, divided into three zones: the centre is composed of one or more large masses of granular protoplasm with many nuclei, known as giant cells; the middle zone chiefly of finely granular epithelial-like cells, and of smaller cells resembling lymph corpuscles and on that account called lymphoid; these constitute also the outer zone, and are gradually diffused among the surrounding tissues. From the giant cells delicate processes pass off, and are continuous with the homogeneous reticulum which permeates the whole tubercle. Absolute non-vascularity is a characteristic of all tubercles; in consequence of defective nutrition their centres undergo molecular disintegration, and by degrees the tubercle is converted into a yellowish material, having the appearance and consistence of cheese; a process described as caseation. The caseous material liquefies and undergoes suppuration and ulceration, or it becomes dried up, shrunken, encapsuled, and ultimately infiltrated with calcareous matter. The cellular elements may be replaced by fibrous tissue, and the 'fibroid' tubercle results.

Disease of the lymphatic glands has long been considered pathognomonic of scrofula, and has come to be considered naturally under that heading. According to the observations of Treves,* the disease begins near the centre of the gland. The commencement of the tubercular process, at first, can only be recognised as patches where the lymph cells are thickly aggregated; large "epithelioid" cells soon make their appearance, the reticulum of the gland becomes closer and coarser, the trabeculæ infiltrated with leucocytes, and the process is completed. J. Arnold,† who examined ninety specimens, states that giant cells are seldom observed; but some scrofulous glands present tubercle in its most typical form. The primary nodules become merged into larger masses, and the anatomical features of the gland are lost. Caseation and suppuration soon follow, or, in chronic cases, the proper substance of the gland becomes converted into fibrous tissue.

Koch, and subsequent observers, have demonstrated rod-like, non-motile bacilli in all forms of tuberculous and scrofulous disease. The bacilli measure in length one quarter to half the diameter of a red blood corpuscle; they are smooth or beaded, and some contain bright oval spores. In their reaction to reagents they differ from all bacilli except those of leprosy. They are most abundant in recent tubercles,

* See his essay on scrofula, to which I am considerably indebted: "System of Surgery," vol. i., p. 226; ed. by Holmes and Hulke; 1883.

† Cent. f. Med. Wissenschaft, p. 86; 1883.

and chiefly occupy the giant cells, but are scanty or absent in old caseous and fibrous nodules. This fact renders their absence, on microscopic examination, of doubtful diagnostic value in some surgical diseases.*

The bacilli, separated from all extraneous matter by cultivation through several generations, invariably produce tuberculosis in animals into which they are introduced by inoculation; and the result is the same† whether the bacilli be originally obtained from tuberculous or scrofulous material. That the characteristic bacilli are the active agent in all forms of tuberculous and scrofulous disease may, therefore, be considered experimentally proven; and their presence explains the infective property of tuberculous material long since discovered by Villemin and others.

The pathological anatomy of scrofula and tuberculosis is identical, their etiology is similar, they may be combined in the same individual, and either one may give rise to the other, but clinically there is the widest difference between, for example, the rapidly fatal course of miliary tuberculosis and the slow, chronic course of scrofulous gland disease. This is the only justification for the retention of the confusing term scrofula. The difference probably depends, in great measure, on the organ or structure, *the soil* in which the disease is implanted, and partly, perhaps, on modifications of the *seed or materies morbii*; age is considered by Billroth to be the most important factor in constituting their clinical dissimilarity. Although in scrofula localisation is the rule, yet generalisation is sufficiently

* In pus taken from presumably tuberculous abscesses connected with bones, joints, lymphatic glands, and soft parts, Schlegtendal found bacilli in seventeen but none in twenty-three cases; in fistulæ and ulcerations the results were positive in nine and negative in fifty-one cases.

† The material from scrofulous glands would appear, however, to be slightly less virulent than tubercular matter. (*See* Nélaton; Cent. f. Chirurgie, p. 1, 1885.)

frequent to be a serious consideration.* On the other hand, many cases of external tubercle, or so-called scrofula, are secondary to pulmonary disease; Konig† states that only twenty per cent. of his cases of bone disease were primary, the remainder being secondary to phthisis. Different scrofulous manifestations are rarely combined in the same individual, but various parts may be attacked consecutively, the disease in one organ or tissue subsiding as that in another progresses.

Predisposing causes and heredity.—A favourable *soil*, that is, a condition of the tissues conducive to the development of tubercle, may be inherited, or may be acquired by mal-hygienic conditions, producing defective nutrition; again, these conditions may intensify an inherited predisposition, the two influences relatively varying in degree in different cases. The influence of heredity may in great part, but not entirely, be explained by the transmission of a tendency to catarrh, and of certain structural peculiarities, as a flat chest in the phthisical. It is, however, the peculiarity of the *soil* which is transmitted, not the *seed* as in congenital syphilis; although instances of direct transmission of tubercle from mother to fœtus have undoubtedly occurred. Some children of tuberculous parents may show manifestations of scrofula, others of tuberculosis.

Exciting causes.—Chief among these are chronic inflammation and injury. Chronic inflammation of mucous membranes rich in lymphatic structures, as the pharynx, bronchi, and intestines, offer exceptionably favourable conditions for the development of scrofula and tuberculosis. This fact is especially evident in the case of scrofulous gland disease, the

* Six out of eighty-seven cases of scrofulous disease of bones and joints traced by Kiener, died with tuberculosis.

† "Die Tubereulose der Knochen u. Gelenkœ." Berlin, 1884.

origin of which may nearly always be traced to a pharyngitis, often with enlarged tonsils, or to ophthalmia, otitis, periodontitis, or eczema capitis.* Injury plays an important part as an exciting cause of tuberculous bone and joint diseases; a slight blow or sprain of a joint is sufficient to induce the disease in those strongly predisposed. Schüller succeeded, by blows on the part, in exciting tuberculous joint disease in animals which had been caused to inhale tubercular matter.

Age.—Scrofula is a disease of early life, the period from three to fifteen years being that in which the disease is commonest. Cases of late scrofula, oftener of the bones and genito-urinary organs, occur between twenty and thirty. Old age is not exempt, for in individuals of sixty to eighty scrofulous affections are seen, which neither in their seat nor general characters differ from the same disease in early life.

Physiognomy.—Much stress was formerly laid on the physiognomy of scrofula and tuberculosis. The characters on which stress was laid were chiefly those of delicate health; and many of the most marked features, as the thick upper lip, ophthalmia, and eczema are the direct results and not exciting causes of the disease. The chief types of this physiognomy have been designated from the temperament of the individuals, as the sanguine and the phlegmatic or lymphatic. Those of the sanguine type are described as being slim, well made, with oval faces, regular features, thin skins, and fine hair, which is often light. This type is considered especially prone to the affections described as tuberculous. The phlegmatic type offers a complete contrast to the foregoing. The subjects of it are squat, thick-set, with square plain faces, expanded alæ nasi, coarse skins, muddy complexions, and coarse, dark hair. They

* *See* an analysis of cases by Garré; *Deutsche Zeitschrift f. Chir.*, bd. xix., hft. 6, s. 529.

present the most typical manifestations of scrofula. A cross or variety intermediate between these types may be recognised, and is designated "pretty struma" from the character of the features.

Clinical manifestations.—The clinical manifestations of scrofula, with the exception of the glandular enlargements and some others more especially considered pathognomonic, can only be mentioned here, a full description being relegated to the chapters on the diseases of the particular organs involved. Many affect the skin and mucous membranes. Some, as lupus and gummata, are from their origin tubercular; while others, as eczema, ophthalmia, and many affections of mucous membranes, in the light of modern pathology, may be considered as, in their initial stages, simple chronic inflammations in unhealthy subjects, on which the essential element of tuberculous disease becomes directly engrafted. Eczema is exceedingly common in strumous children; it is of the moist form, sometimes pustular, and affects generally the scalp, ears, and the skin around the nostrils. Tinea tarsi, granular lids, and phlyctenular ophthalmia are frequently associated with it. True lupus is by most authorities * regarded as essentially tubercular; and Hebra has described a lichen peculiar to scrofula.

The scrofulous gummata occur as flattened indurated masses, which, according to Benier, either occupy the substance of the skin, or lie beneath the superficial fascia. They sometimes soften in the centre, and discharge broken-down caseous matter through an ulcerated opening in the skin; and, in other instances, they rapidly enlarge and become the seat of a cold abscess.

The frequency of affections of mucous membranes has already been dwelt upon, among the most common being eczema, pharyngitis, otitis media, and a

* Dr. Klein has raised doubts on this point.

catarrhal condition of the intestinal mucous membrane, with which is associated a peculiar form of dyspepsia. The pharyngitis is marked by the formation of numerous pale granulations on the mucous membrane from hypertrophy of the lymphatic follicles; enlargement of the tonsils is also common. Tubercular affections, strictly so-called, also occur as ulcerations of the tongue, larynx, and anus. Affections of bone chiefly take the form of caries; sometimes of gummata beneath the periosteum. Cancellous bone is especially prone to the disease, and, in consequence, the bones of the carpus and tarsus, the articular ends of long bones, and the bodies of the vertebræ are most often attacked.

In the joints the disease either involves the synovial membrane, leading to so-called 'white swelling,' or pulpy degeneration, or its stress falls on the articular ends of the bones. The sheaths of tendons are occasionally affected, primarily or by extension from bone or joint disease. Mention must also be made of tuberculous disease of the joints, urinary tract, testes, and of the rare instances of tuberculosis of the mammary gland, prostate, uterus, and Fallopian tubes.

Dactylitis.—A peculiar disease of the digits known as strumous dactylitis is common in young children. It affects the phalanges, chiefly of the fingers, and gives rise to a tumid, slenderly flask-shaped swelling, with a cold, purple, or livid condition of the skin, which later becomes perforated by sinuses. The disease begins in the centre of the bone and leads to its disintegration.

Scrofulous gland disease.—The etiology of this affection has already been considered; its clinical characters must now engage our attention. The cervical glands are almost exclusively affected, the disease being rare in the axillary and inguinal glands. The glands in the submaxillary region, at the angle of the jaw, and in the posterior triangle are by preference involved. They are usually of moderate size, and may be felt as numerous, somewhat firm, movable swellings on one, or more often on both sides of the neck. Sometimes two or three glands attain a large size, even an inch or more in diameter. In rare instances large conglomerate masses of glands are formed, but these are never completely fused, as in lymphadenoma.

Fig. 7.—Severe Scrofulous Gland Disease.

Suppuration is a common event. A gland softens, the skin over it becomes reddened and thinned, the abscess bursts and gives exit to thin curdy pus; occasionally an abscess forms in the tissue around a gland. The abscess cavity may close tardily, but it frequently gives rise to an obstinate sinus with purple undermined edges; or by further destruction of skin a strumous ulcer is formed. The character of the cicatrices left after healing is peculiar; they are depressed, adherent to the deeper structures, and often fringed by papillæ of skin, or traversed by ridges and bands. Resolution without suppuration also occurs by drying up and mummification of the caseous matter. In the most chronic cases the glands remain for years as firm, indolent nodules.

On section they present a smooth, pale or pinkish, fleshy surface, varied by patches of caseous material and small collections of pus. In chronic cases the section is pale, firm, and fibrous; the capsule is much thickened, and may undergo calcification.

Prognosis of scrofula.—Each case must be considered with reference to the seat and extent of the disease, the constitutional condition of the patient, and especially the presence or absence of symptoms of phthisis, which is little to be apprehended after gland disease, but is frequently associated with bone disease. Miliary tuberculosis is not an uncommon sequela of hip joint disease.

Treatment.—The *general or constitutional treatment* consists in the adoption of measures calculated to improve the general nutrition of the patient, and the administration of alteratives and tonics. A light nourishing diet, not too full, and moderate exercise should be enjoined. Ventilation should not be neglected. Those resident in towns will be benefited by change to the country or seaside. Cod-liver oil is a valuable addition to the diet, but, to be of use, it must be taken in increasing doses, and for a lengthened period. If dyspepsia exist, an occasional dose of soda and rhubarb, or of mercury with chalk should be prescribed. Iodide of potassium may be indicated, with a view to the absorption of chronic thickenings and hypertrophies. Of all medicines the syrup of the iodide of iron is deservedly that in most general use. The saccharated carbonate is, however, preferable for young children. In the treatment of enlarged glands, sulphide of calcium is stated to be of value. Büchner has strongly advocated the employment of arsenic; and, in cases of recent and rapid enlargement, independent observation has convinced me of its utility.

Local treatment of scrofulous glands.—At the outset any source of peripheral irritation must be sought for and remedied. Enlarged tonsils should be at once removed.

The local treatment comprises the application of absorbents and counter-irritants, and the employment of operative measures. The iodide of lead ointment should be rubbed, for some minutes every night and morning, into the skin over the affected glands. Tincture of iodine, being more irritating, is only applicable to extremely chronic enlargements. It is advisable to open abscesses early, either by a puncture or the thermo-cautery.

Our knowledge of the nature of scrofulous disease, and the clinical fact that it tends to spread by local extension from gland to gland, clearly indicates the necessity of eradicating the diseased tissue. This may be accomplished in suitable cases by scooping, igni-puncture, and by excision of the glands. The first named method is applicable to glands which have softened or suppurated, and to sinuses and ulcers; it merely consists in the removal of the diseased tissue with a Volkmann's spoon. As an after-treatment, the insufflation of iodoform is of great value. This drug is credited with a specific influence in checking the formation of tuberculous tissue. Treves employs igni-puncture with considerable success; he considers it applicable to almost any glands which have attained the size of a walnut, and to cases in which there are large adherent masses of glands. It is carried out as follows: a fine point of the thermo-cautery "is thrust through the skin into the substance of the gland, and is passed in several directions through the gland tissue before it is withdrawn." The more radical operation of excision is by most English surgeons only resorted to in selected cases, in which there are two or three much enlarged movable glands near the surface, and in very chronic circumscribed enlargements which have resisted other methods of treatment. The observations of Garré, based on forty cases, show that the results of excision, as regards the return of the disease, are favourable.

In cases of extensive sinuses about the neck, much good may be obtained from keeping the parts at rest by means of Treves' neck splint, or a Sayre's jury-mast.

XX. RICKETS.

FREDERIC S. EVE.

RICKETS is a disease of development, chiefly characterised by softening and bending of the bones from defective organisation, the result of a peculiar form of malnutrition.

The age of its occurrence, as might be anticipated, corresponds to the period when the nutritive organs are most easily deranged, and the osseous system is in active growth, namely, in infancy and early childhood. The great majority of cases of rickets are brought for treatment between the ages of ten months and two and a half years;* in rare instances the disease manifests itself before the sixth month.

So-called *fœtal rickets* is allied to cretinism, and has nothing in common with true rickets.

Examples of *late rickets* are met with from the seventh to the tenth year; some such cases† are, however, more nearly related to mollities ossium than to rickets. Certain deformities (commonly appearing at puberty, and before the development of the osseous system is completed), as flat foot, genu valgum and varum, and lateral curvature of the spine, may probably, in some instances, be referred to changes representing a slight grade of rickets. Mr. Clement Lucas‡ has shown that, not unfrequently, slight albuminuria co-exists in these cases.

Symptoms.—Bending of the bones is often the

* *See* "Diseases of Children," by Dr. Goodhart, for tables by Drs. Gee and Goodhart.

† *See* specimens in the Museum of Royal College of Surgeons, Nos. 679 and 3879.

‡ *Lancet*, June 9th, 1883.

first symptom by which attention is drawn to the disease, but in many, especially in acute cases, prodromata appear. The child sweats excessively over the head and neck; he is restless and throws off the bed clothes at night; his limbs, and even the muscles, are tender, so that he cries on being handled. His abdomen becomes large and tumid, and he is subject to digestive disturbances.

The osseous lesions are soon manifest. The ends of the long bones are the seat of a rounded enlargement, more apparent in those which are subcutaneous, as the lower ends of the radius and of the tibia and fibula. A similar enlargement of the costochondral junctions gives rise to the "beaded ribs" or "rickety rosary." The child lies passive, or, if it have begun to walk, it is "taken off its feet." The head assumes a peculiar and characteristic form. In contrast to the small face it appears enlarged, its posterior segment is expanded, its antero-posterior diameter elongated, and the frontal and parietal eminences are unduly prominent. The fontanelles remain long unclosed and bulging. Small areas are sometimes observed over the posterior segment of the skull, where the bone is so thinned that it yields with a crackling sensation to pressure of the finger. This condition, known as cranio-tabes, was formerly ascribed exclusively to rickets, but recent observations* have shown that it is, in the larger percentage of cases, associated with congenital syphilis.

Dentition is delayed, and the teeth are ill-formed and prone to decay.

The spine yields to the superimposed weight, and assumes a uniform antero-posterior curve, with the convexity backwards, and called the kyphotic curve.

The thorax presents the deformity known as

* *See* the papers by Drs. Lees and Barlow; Trans. Path. Soc., vol. xxxii., p. 323.

pigeon-breast; and the limbs become curved in a manner which may be more conveniently described farther on.

Jenner showed that the lymphatic glands are always slightly enlarged; but enlargement of the liver and spleen is considered by later observers to be exceptional.

Complications. — Rickety children are liable to certain nervous affections, as laryngismus stridulus, convulsions, and tetany. Bronchitis is a common and most serious complication, owing to the yielding nature of the thoracic walls.

Pathological anatomy.—The changes in the form of the skull have already been alluded to. In the early stage of rickets the membrane bones are thin, light, porous in texture, and cranio-tabes may be present in the occipital and posterior portion of the parietal bones. In the later stages the sutures are often obliterated, and the.skull becomes thickened.

The pigeon-breast deformity consists in a projection forwards of the sternum in a keel-like form. The dorsal surface of the thorax is flattened; the ribs at a point just beyond the angles are bent sharply towards the middle line; and external to the costo-chondral junctions there is a recession of the chest wall giving rise to a vertical groove, which extends along the front of the chest as low as the ninth and tenth ribs. A little below the level of the nipple line there is the appearance of a transverse constriction of the thorax, due to falling in of its walls above the parts where they expand to accommodate the liver and spleen. The form of the rickety thorax may be explained by the inability of the softened ribs to overcome during inspiration the elasticity of the lung and the atmospheric pressure; the latter cause is brought into play when the capacity of the lung is diminished by collapse from plugging of the smaller bronchial tubes with mucus.* The typical rickety pelvis is flattened antero-posteriorly and its outlet is contracted by bending inwards of the tuber ischia. But it may, in cases of extreme softening of the bones, assume the cordiform or beaked shape, considered characteristic of mollities ossium. Various distortions and curvatures of the long bones occur, their direction being determined by the lines along which weight is transmitted, by the weight of dependent parts, and by position. These factors produce different results, varying as regards the position most commonly assumed by the child, whether the recumbent or sitting; and on the circumstance of its ability to walk or crawl. Muscular action may exaggerate a curve when formed, but is not competent to induce it.

The normal curves of the clavicle are exaggerated. The humerus presents an angular curve outwards, just below the insertion of the deltoid, and is bent forwards at its lower end. The radius and ulna are curved outwards, that is, towards the radial side. The femora are curved forwards and slightly outwards. The bones of the leg offer a greater variation in the direction of the curves than any others. The commonest deformity consists in a bending of the tibia and fibula forwards and inwards; as this condition is usually associated with bending of the femur outwards, the bones of the right limb often assume an S-like curve, while the curves are necessarily reversed on the left side. Frequently the leg is bent forwards and outwards, especially when there is a general bending outwards of the whole limb, or bandy-leg. More rarely a sharp bend, more or less directly forwards, in the lower half of the tibia is observed. In old cases the tibia and fibula are widened and flattened from side to side.

* For a full explanation of the mechanism of the production of the rickety thorax the student may refer to Sir Wm. Jenner's Lectures on Rickets; *Medical Times and Gazette*, p. 262; 1860.

The widening is due in great part to the formation of a ridge or buttress of bone along the concavity of the curve (constituting a chord of the arc described), and is more conspicuous after the cure of the disease, and in curvatures of a high grade; a similar ridge is observed in other bones, notably along the linea aspera of the femur. It materially adds to the strength of the bones.

Other changes may be observed which can only be mentioned here: the articular surfaces are flattened and the neck of the femur yields. Later, deformities of the knee and foot occur, which will be described in the article on Orthopædic Surgery. Fractures from slight violence, and the spontaneous giving way of bones, usually of the ribs or of the bones of the lower extremities, are not uncommon in severe cases. They are often incomplete and unite without delay.

At first the long bones are soft, may even admit of being cut with a knife, and the compact tissue is thin. After cure has taken place by deposition of lime salts, their walls become thickened, and the osseous tissue dense even to induration. Dwarfing may result from premature union of the epiphyses.

It is at the epiphysial lines that the most characteristic changes of rickets are situated. The semitransparent layer of 'intermediary' or proliferating cartilage between the diaphyses and epiphyses is increased from the normal thickness of one or one-and-half millimetres to four, six, or more. The limit between it and the developing bone at the extremity of the diaphysis is transformed from a perfectly well-defined and even line to a boundary broken by the jutting out of irregular masses of cartilage. The layer of developing bone or 'ossiform layer' is soft, red, vascular, spongy, and contains a few irregular bone trabeculæ, and islets of cartilage, perhaps calcified, which may be observed far up in the shaft. Of this bird's-eye view the microscope gives a more striking picture; it shows that the cartilage cells of the intermediary layer are enlarged, and in place of the arrangement in vertical columns they are collected in masses or clumps; that the delicate vertical bands of calcified cartilage connecting the intermediary with the ossiform layers, and on which the young bone is first deposited, are scanty or absent; and, finally, that the irregular and scattered trabeculæ in the layer of developing bone are lined with a broad, almost homogeneous, non-laminated substance, containing small elongated nuclei. It has been pointed out by Pommer, and I had myself observed the fact, that this substance represents uncalcified bone matrix. The medullary spaces are large, and the medulla is vascular and cellular, but may be transformed into a finely fibrillated substance containing elongated and stellate cells. It may be readily ascertained by microscopic examination that the apparent enlargement of the epiphyses, contrary to the general opinion, is chiefly due to a bulging outwards of the walls of the bone at the level of the intermediary cartilage and above the epiphysis itself.

Changes, analogous to those above described, are observable in the intramembranous forms of ossification. The deep layer of the periosteum is much thickened by a layer of fibrillar material, into which a few incompletely calcified trabeculæ of bone project.

From this brief description of the histology of rickets it will be evident that the essential feature of the osseous changes consists in the defective deposition of lime salts in the newly formed bone-matrix, together with an irregularity, and, perhaps, an acceleration of the processes of osseous formation.

This conclusion is supported by the chemical examination of rickety bone, which shows 33 to 52 per cent. of earthy salts, against 63 to 65 in normal bone. Pommer asserts that the absorption of previously formed bone does not exceed that which is usual and normal in the bones during childhood.

In explaining the results of rickets it is of importance to bear in mind that the continued, although not abnormally, accelerated absorption of bone around the medullary canal, if not compensated for by the formation of firm bone beneath the periosteum, must ultimately result in the complete loss of the stability of the bone.

As regards the visceral lesions, it is maintained by competent observers that the 'glue-like change' in the liver and spleen is due to increase of the connective tissue elements.

Various hypotheses, all equally conjectural, have been brought forward to explain the phenomena of rickets: that it is due to irritation of osseous tissue from the presence of lactic acid in the blood, or, according to Kassowitz, that the deposition of lime salts is delayed by a chronic hyperæmia, and an abnormally abundant new formation of blood-vessels in the ossifying cartilage and periosteum. Further, that from the same causes there is increased absorption of bone.

Etiology.—The most important factor in the production of rickets is defective and unsuitable food, and it has, therefore, been described as a *diet* disease. Prolonged lactation, defective quality of the milk from ill-health in the mother, feeding with sour or poor milk and at too frequent intervals, and the too early administration of starchy foods;* these, singly or combined, are among the chief causes to which rickets may be traced. Mal-hygienic conditions generally, foul air, dirt, and the accompaniments of the squalor and over-crowding of large towns, are important predisposing causes. They engender a weakly condition

* Dr. Baxter found that in 92 of 100 cases of rickets starchy food had been given before the age of twelve months (Trans. Path. Soc., vol. xxxii.; 1881).

of the system with impaired digestion, and the consequent defective assimilation often combines with defective feeding in bringing about the lamentable result. The absence of, or inability to assimilate, certain constituents, rather than the scantiness of food, may, perhaps, be considered the chief determining condition, for the larger proportion of rickety children are well nourished; and rickets may be induced in young animals by feeding them on substances deficient in lime salts. The effects of artificial food, confinement, and climate are manifest in the frequency of rickets in animals kept in zoological gardens.

Prognosis and diagnosis.—The prognosis as regards life depends on the presence or absence of the complications already alluded to, and especially bronchitis; as regards the cure of distortion, on its degree, and the stage at which the disease comes under observation. If treatment be adopted sufficiently early curved bones tend, in process of growth, to become straighter without mechanical means.

Congenital syphilis is the disease most important to be borne in mind in cases of doubtful diagnosis.

Treatment.—The principle of the treatment of rickets is summed up in the following sentence: "Whatever agents are calculated to improve the general health are the most efficient for curing the rachitic diathesis and, where that is not possible, for preventing its worst effects." * Scrupulous cleanliness, with daily cold or tepid sponging, ventilation, fresh air (if possible, sea air), and, above all, dieting, are requisite to its successful treatment. Food should be allowed at stated intervals only. For infants under eight months brought up by hand, the most suitable diet consists of fresh cow's milk diluted with a fourth part of lime-water, and sweetened with milk-sugar.

* Jenner, *op. cit.*, p. 467.

Beef-juice may be given if milk is not digested, or is rejected.

The natural food of those infants who are suckled may be supplemented by cow's milk, and the health of the mother should be looked to. After weaning, which must be insisted on after the tenth or twelfth month, milk should still constitute the chief diet, but beef-tea, farinaceous puddings, and eggs may be added; and after the twelfth month finely minced or pounded meat.

The bowels will usually require attention; and an antacid, as soda and prepared chalk, will in many cases be indicated. Iron and cod-liver oil are most valuable remedies. The phosphate of iron and lime, known as Parrish's food, is held in high estimation; among other preparations the lacto-phosphate of lime, and iron and steel wine are largely used. Cod-liver oil is especially indicated if there be emaciation. The child should be kept off its feet or limited exercise only permitted, except in slight cases. Splints may be employed both for the purposes of checking deformity and preventing the child from walking. Mechanical, with other methods of surgical treatment, will be considered in the article on Orthopædic Surgery.

XXI. HÆMOPHILIA.

FREDERICK TREVES.

HÆMOPHILIA or the bleeder disease is defined as a congenital and habitual hæmorrhagic diathesis. The subjects of it are liable to severe and obstinate hæmorrhages which may occur spontaneously, or may follow injuries, often of the slightest kind.

The disease is noted in the patient from the commencement of life; it may be said to exist so long as he exists, and does not appear (except in some rare and imperfectly understood instances) to be ever acquired.

The malady is in nearly every case *hereditary*. Grandidier speaks of it as "the most hereditary of all hereditary diseases," and the subjects of it will generally be found to belong to definite "bleeder families." It attacks the individual members of a family extensively, and it is estimated that there will be three bleeders to every family affected. Hæmophilia is nearly thirteen times more common in males than in females.

The disease is *transmitted* in a remarkable way. It is handed down, not by the bleeders themselves, but in nearly every instance by the non-bleeder members of the family, and almost exclusively by the females. Thus, if there be six children in a bleeder family (three boys and three girls) the boys will be bleeders, but the girls most probably will not be affected. If they all marry and have children, the children of the bleeder males will most probably be non-bleeders, whereas the children of the females will almost certainly present the disease.

Hæmophilia has a peculiar *geographical* distribution. It is most common in Germany, and then in order of frequency in Great Britain, in North America, and in France. No cases have been reported from Italy, Greece, Turkey, Spain, or Portugal.

Bleeders, apart from their special diathesis, present no distinctive constitutional condition. There is nothing peculiar in their physique, their complexion, their pathological tendencies, their general health. They frequently possess a very fine and transparent skin, but this feature is by no means constant. If not suffering from the effects of hæmorrhage, they may appear to be in robust health.

The actual **cause** of the disease is entirely unknown, and is merely a matter of speculation. Its pathological anatomy is no more precise. In many fatal cases of hæmophilia there has been no evidence of a primary disease, and no abnormality detected in the vascular system. In other instances the heart, and especially the left ventricle, has been found hypertrophied, and the arteries to be abnormally thin, the atrophy involving espceially the intima. No peculiarity has been detected in the blood.

The hæmorrhages are usually due to injury. Fatal bleeding has followed scratches with pins, the removal of teeth, leech bites, the rupture of the hymen, and the most trifling wounds, as well as lesions of greater magnitude.

It is remarkable that serious bleeding very rarely follows the wounds made in vaccination.

Continuous and even quite slight pressure may cause very extensive subcutaneous hæmorrhages. Some of these extravasations may attain great size. Some may occur spontaneously, and are then most often met with on the scalp or about the genitals.

Spontaneous hæmorrhage is usually from a mucous surface, most usually from the nose, and then in order of frequency from the gums, the alimentary canal, and the genito-urinary passages. It is rare from serous surfaces, although bleeding into joints is not very uncommon. Traumatic bleeding increases the tendency to spontaneous bleeding.

If the bleeding part can be examined the blood will be found to ooze from numerous points, and not spout from one or two vessels. The blood poured out presents no peculiarity of any kind. The hæmorrhage is never furious, but it may continue for many days, and even for weeks.

Bleeders will bear great losses of blood remarkably well, and will recover very rapidly when the hæmorrhage has ceased.

The **symptoms** differ in no way from the ordinary phenomena of prolonged bleeding as observed in the otherwise healthy.

The tendency to bleed is more marked at some periods than at others, so that at certain times wounds in bleeders may be attended with only the normal amount of hæmorrhage. The precise nature of these periods is quite unknown.

The affection usually first shows itself at the beginning of the first dentition. Other marked periods for bleeding are the second dentition and puberty. The manifestations decline in advancing years so that the disease is much more marked in youth than in middle life: 70 per cent. of the first outbreaks fall within the first two years of life.

Often in spontaneous bleeding there will be prodromata in the form of flushings, a sense of heat, beating of arteries, and restlessness.

One peculiarity remains to be noted. There is a marked association between hæmophilia and rheumatism. Bleeders are very liable to painful swelling of joints, and to muscular pains. The nature of this association remains unexplained.

The disease is very fatal. Most of the patients die young, and more than fifty per cent. never reach the age of seven years. The first bleeding may prove fatal, or a great number of hæmorrhages may occur before death. On the other hand, a patient may bleed once, recover, and never bleed to excess again. A few bleeders have attained old age.

In the matter of **treatment,** nothing, so far as is known, can be done to prevent bleeding in a known bleeder apart from keeping him from risks of injury. In cases of spontaneous internal hæmorrhage the patient should be kept at rest in the recumbent posture, the bowels may be made to act vigorously if the hæmorrhage be not from the intestine; all stimulants must be avoided and the patient treated with acetate of lead, in full doses, or with ergotin or sclerotic acid.

Transfusion has proved of no avail, and indeed, when it has been performed, the bleeding from the operation wound has merely added to the patient's danger.

In cases of traumatic hæmorrhage, the oozing may be best checked by a tampon soaked in perchloride of iron, and applied so as to exercise considerable pressure upon the part. This is certainly the best local measure. The actual cautery is seldom of much avail, and acupressure and the use of ligatures are apt to add fresh risks to the case by increasing the wound. Ice may have a good effect for a while, but on its removal, the hyperæmia that follows the use of cold may lead to worse bleeding than ever. In any case acetate of lead, ergot, or sclerotic acid should be administered.

XXII. SYPHILIS.

Jonathan Hutchinson, F.R.S.

It is customary to divide the course of syphilis into three stages, and it is no forced analogy to compare them with those met with in the exanthemata, *e.g.* scarlet-fever or small-pox. In the latter there is a period of incubation which is of remarkably uniform duration, then follows the outbreak of an eruption, with other phenomena which vary with each specific fever, and finally the patient is left liable to certain morbid processes, which are usually non-symmetrical, and have little or no tendency to spontaneously subside, the so-called sequelæ.

The stages of syphilis are far more protracted than those of the acute exanthem. Its first two are to be reckoned in months instead of days, whilst the tertiary stage may even be considered to last for the rest of the patient's life.

The primary stage dates from inoculation to the appearance of constitutional symptoms, which, from the fact that the virus is then circulating throughout the whole body, are symmetrical. It lasts from six weeks to three months, being in the majority of cases about eight weeks. It is, however, quite certain that long before this time the disease has ceased to be a purely local one, and hence the entire removal of an indurated chancre in no way prevents infection. For the hardening of the sore is closely followed by enlargement and hardness in the nearest lymphatic glands, almost equally characteristic of syphilis, and in some cases even more useful in the diagnosis of the disease than the features of the sore itself.

The secondary stage may for practical purposes be held to last until the end of the second year. Some of its phenomena, however, often continue to recur long after that period, but they do so in a somewhat irregular manner. Deviations from symmetry become common. As a general rule, it may be asserted that the farther from the date of infection that syphilitic lesions appear the less likely are they to be symmetrical, and the less will they tend to undergo spontaneous cure. Some remarkable exceptions to this very constant rule are found in inherited syphilis, in which symmetrical nodes and symmetrical affections of the eye and ear are frequently seen many years after the secondary stage. These exceptions are probably to be explained by some law of development of tissues, for all the other phenomena of inherited syphilis are, like those of the acquired disease, symmetrical only in the early stages.

The tertiary stage is characterised by the frequent absence of symmetry, the tendency in all its processes to serpiginous spreading, and by the production of gummous swellings in cellular tissue, periosteum, or muscle. These latter may ulcerate and spread deeply. They are persistent, and show no tendency to spontaneous cure. Diseases of the nervous system and of many of the viscera are frequent. The tendency to phagedænic inflammation, which may be seen at any stage of syphilis, is also frequent now.

The processes of contagion.—The virus of syphilis may be acquired (1) from the secretion of a primary sore; (2) from the blood, and probably from all cell elements during the secondary stage, especially all products of inflammation; (3) by the placental circulation.

The infection is transmitted through some abrasion of the cuticle, or through an uninjured surface which is either soft and thin, or is exposed, owing to its local conditions, to the presence of the virus for a considerable time (witness the frequency of chancres at the retro-preputial fold, and of "midwifery sores" round or under the nail).

The primary sore.—If the syphilitic virus alone has been inoculated, little or nothing will be noticed until from three to five weeks later, when a small red itching spot appears, which becomes papular, then changes to a pustule, which bursts, leaving a small ulcer, which is characterised by the insignificant amount of its secretion and the increasing hardness of its base. This induration is best estimated by gently pinching the sore between finger and thumb, and it will usually be noticed that it extends much beyond the actual "sore." There may indeed be no ulcer.

The nearest group of lymphatic glands usually becomes indolently enlarged and hard, each gland remaining distinct, alike from the others and from the surrounding tissues. The syphilitic bubo must be looked for in the following places: (1) in the oblique inguinal set of glands when the chancre is on the genitals or near the anus; (2) in the axilla when on the arm or breast, as well as, perhaps, just above the elbow when the sore is on the hand; (3) in the submaxillary set when on the tongue, lips, or chin; (4) in the pre-auricular glands when on the eyelids, etc.

The *induration* both of chancre and glands persists, as a rule, for several weeks, unless interfered with by mercury, but varies much in degree and extent in different cases. It usually disappears quickly if mercury is given. A good deal depends on the site of the chancre. The most characteristic hard sores are met with at the fold between the prepuce and glans; on the glans itself induration is rarely marked, excepting at the meatus or on the corona. The indurated chancre of the meatus is very peculiar, and must be carefully distinguished from the pouting of the lips which often attends gonorrhœa. Induration is less marked in erratic chancres, especially in those occurring on the face, and it is often absent in chancres in women. It is by no means a constant phenomenon of infective sores, and often disappears quickly without treatment. It is also liable to be simulated after the use of caustics, and to be concealed by coincident inflammation or ulceration of the surrounding parts.

As many sites as have been inoculated at the same time will develop into primary chancres, but after these have developed it is not possible to produce fresh ones on the same patient.

The so-called *soft chancre* (or better, the *non-infecting sore*) is hardly ever recognised, except on the genitals; its secretion is more purulent and much more free than that of a hard or Hunterian chancre. It appears within a few days of contagion, and its bubo is of the same nature as the sore itself, *i.e.* an inflamed and painful one, tending to break down into an abscess.

Phagedæna.—The soft sore may inflame and ulcerate, but it very rarely assumes the condition of true phagedæna. This term is reserved for ulceration which eats deeply into the tissues, opens blood-vessels, and which, as a rule, continues to spread indefinitely unless checked by treatment. Phagedæna is a rare complication of chancres, and seldom starts in an indurated sore until the latter has existed some time. In severe cases phagedænic ulceration may be accompanied by sloughing, and the process is often very painful. It is far more common in men than in women, and is especially prone to happen to concealed chancres, those situated within a tight prepuce. The retention of irritating discharges is no doubt very influential in producing it.

Its nature as a local modification of the inflammatory process is well illustrated by the measures needed for its *treatment*. The prepuce should be slit up, the sore freely exposed and cleaned, and the patient should be made to sit in a warm bath (the water of which is frequently changed, and may be charged with some antiseptic) for many hours daily, applying iodoform when he leaves the bath. A few days of this treatment usually completely checks the destructive process, but in a few cases the actual cautery or the acid nitrate of mercury may be required. It is needless to point out which is the least painful method of treatment. Powdered iodoform is also an invaluable remedy in phagedæna, and will often succeed alone.

If phagedæna be neglected, a considerable portion of the penis may be destroyed, or a urinary fistula may result. Hæmorrhage may in some cases be profuse and recurrent. In cases of concealed sores the occurrence of bleeding may be held to denote phagedæna.

Since the occurrence of phagedæna is almost invariably a concomitant of the infecting sore, mercury ought always to be given unless it definitely disagrees, and with it should be combined full doses of iron and opium.

Syphilitic inflammations of all kinds, whether primary, secondary, or tertiary, are liable to take on phagedænic action; and in inherited syphilis it is seen occasionally, both on the skin and within the mouth and nose. If specifics and the measures enumerated have failed to completely arrest the process, the patient should be sent to the seaside. If once quite cured, it scarcely ever recurs, thus strongly pointing to a local rather than a constitutional origin; this is confirmed by the fact that its subjects are sometimes in apparently robust health. There is strong evidence that hospital gangrene may be started from cases of syphilitic phagedæna.

Chancres in women are usually seen on the labia or nymphæ, less often on the fourchette or clitoris, very rarely on the os uteri, and hardly ever on the vaginal wall. This exception has been explained by the thickness of the epithelium and the infrequency of gland orifices in this position.

To recapitulate the main points in **the diagnosis of chancres.**

Infecting Chancres.	*Non-infecting or Abortive Chancres.*
1. Usually single.	1. Often multiple.
2. May occur on any part of the body.	2. Occurs almost solely on the genitals.
3. Cannot be re-inoculated on the same patient.	3. Easily inoculated over and over again on the same patient. Accidental inoculation of adjacent parts often witnessed.
4. Base indurated, secretion scanty and thin.	4. Base not hard, secretion free and purulent.
5. Appears from three to five weeks after contagion.	5. Appears within a few days.
6. Very amenable to mercury.	6. Not so markedly affected by mercury.
7. Bubo generally painless, indolent, and does not usually suppurate.	7. Bubo generally inflamed, adherent, very liable to suppurate.
8. Followed by secondary symptoms.	8. No secondaries follow it.

Infecting chancres on all parts, but especially those on the fingers, may, however, be much inflamed and very painful; and there is no doubt that on the genitals a sore may begin early, and in all respects conform to the characters of a non-infecting chancre, and yet at the end of a month may become hard, and be followed by syphilis. Remembering this fact, a surgeon will act wisely in giving no positive opinion until six weeks or two months have elapsed.

Treatment of chancres.—It is still doubtful whether excision or free cauterisation of a venereal sore within a few days of contagion can prevent infection; some observers (Berkeley Hill, and others) hold that it does not. Cleanliness and the use of iodoform in powder or ointment (ʒj to ℥j of vaseline) will constitute the treatment for all non-indurated chancres. If there is no doubt that the sore is an infecting one, it is well to apply black wash and to begin mercury at once, with a view of minimising or preventing the appearance of seeondaries. In a large proportion of cases an efficient and long-continued course will entirely prevent all secondary phenomena.

The secondary eruptions.—The earliest to appear is usually a *roseola*, a painless rash unattended by itching, which often resembles that of measles. It is best observed on the chest and abdomen, is very evanescent, and may be better marked at one period of the day than another. About the same time slight *sore throat* is eomplained of, the temperature rises a degree or two every evening, and there may be headache, pains in the back, malaise, etc. These febrile symptoms, as a rule, however, preeede the roseola; and before or shortly after the latter fades away various other eruptions may appear. The *papular* form is the most common one, but a *lichenoid* is also frequent; less commonly we see a sort of acne, or a vesicular or pustular eruption. The surgeon should be on his guard, lest he mistake a syphilide for some other skin disease, such as psoriasis, lichen ruber, copaiba rash, or possibly even small-pox. In respect to the last-named, perhaps the best diagnostic signs are the slow course of the syphilide, and the absence of the peculiar smell noticed in small-pox; for considerable fever may be present with its syphilitic imitation. A general syphilide is rarely limited to one type; for instance, a papular or psoriasis-like eruption may be mixed with acne or rupia, etc. This "polymorphism," the absence of pain or itching, and the lean-ham colour of spots which have existed some time, are most valuable, though not infallible, tests of a syphilitic origin. Some syphilides are deeply coloured, especially when occurring on the lower extremities, and in individuals with a naturally dark skin; but the scars left by an ulcerating syphilide may often be quite pigmentless.

A very common eruption is one resembling *psoriasis*, but differing from the usual persistent form in the following points: 1. It rarely occurs in large areas. 2. It does not specially affect the psoriasis positions (extensor surfaces and the skin immediately over bony prominences). 3. Whilst there is much less scaling, there is more subjacent infiltration. The scales are readily peeled off, and the eruption lasts a comparatively short time.

Syphilis may imitate the other "dartrous" eruptions very closely, especially the smooth-topped lichen known as lichen planus. One like pemphigus is, however, rarely seen except in congenital syphilis, and then only in peculiar cases.

During the latter part of the secondary stage *rupia* is sometimes met with. This name is given to an eruption with circular or oval ulcers, over which a heaped up mass of scab has formed and dried (resembling a limpet shell); it always leaves scars, and is often a sign of feeble constitution. Hence, in its treatment, tonics and sea air should, if possible, be conjoined with the use of mercury. It is an error to class rupia as tertiary, or to say that it tends to deep ulceration. It is also usually symmetrical, a fact which denotes its secondary position.

To recapitulate *the features of secondary syphilides:* they may closely simulate a large number of non-specific eruptions (whilst, with perhaps the exception of rupia, there is no eruption peculiar to syphilis); they are fairly symmetrical, cause little local discomfort, are usually polymorphous, have frequently a brownish-red colour, tend to fade away or cicatrise after a few weeks or months if untreated, and disappear rapidly under the influence of mercury.

It may be added that the front of the trunk, the flexor surfaces of the limbs (especially the arms), that part of the back between the shoulders, the back of the neck, and the upper part of the forehead, are their favourite sites.

Condyloma.—If a patch of syphilitic eruption is situated in the mouth or on some part of the skin which is continually kept moist, such as the margin of the anus, the inguino-scrotal fold, the under-surface of the breast in stout women, or the axillæ, what is known as a condyloma is produced. This is a congested and elevated patch, the surface of which is smooth and not split up into a number of papillæ as is a wart. At the same time, secondary syphilis produces warty as well as condylomatous growths; this is especially to be noticed on the tongue. It is to be observed that all gradations of character between condylomata and warts are to be observed. If a condyloma be kept dry and clean, and a mercurial powder (one part of calomel to two of oxide of zinc) be applied, it is surprising with what rapidity it clears off.

Iritis.—The constitutional symptoms accompanying the first rash have already been mentioned. A few weeks or months later, other more serious lesions are liable to occur, especially affecting the eyes, the mucous membranes, and the bones. Of the first the most common is iritis, coming on usually from three to six months after infection, and often involving both eyes, though rarely commencing symmetrically. Its symptoms are ciliary congestion, a discoloured iris, an irregular pupil, and a variable amount of pain in the eye and forehead, with photophobia. The best test consists in the use of atropine, when, if there is iritis, the pupil will slowly become oval or irregular, and spots of uveal pigment or adhesions will be seen on the lens. Sometimes a number of minute dots on the back of the cornea (lower part) are also observed; occasionally little vascular nodules of lymph are present on the iris, an interesting demonstration of what probably occurs in some degree in many parts of the body during secondary syphilis.

It is sometimes difficult to distinguish the iritis, which is of syphilitic, from that which is of rheumatic origin. The best marks of the former are the comparative absence of pain, the large amount of effusion into the iris, and the presence of small nodules on its surface. The latter are, however, rare. In the rheumatic form, in addition to the history of frequent recurrences, there are usually much congestion, pain, and photophobia. In many cases the patient's history must be the chief guide.

Treatment of syphilitic iritis.—If the case is seen early, or if there is any hope of the adhesions yielding, atropine drops (four grains to the ounce of water) should be used very frequently, and mercury should be pushed (*e.g.* one grain of grey powder may be given every three hours until the gums are affected, and then three times a day); the patient should avoid stimulants, or anything likely to cause diarrhœa, and should rest the eyes in a darkened room or with a shade. In some cases iodide of potassium is of great value, whilst if the pain be severe it can be relieved by leeching the temples. The extreme importance of energetic and early treatment of syphilitic iritis cannot be too strongly impressed. Mercury and atropine have saved many eyes from incurable blindness. For if strong adhesions form, and particularly if the whole margin of the pupil becomes adherent (total posterior synechia), the eye may become disorganised, the tension may alter, and secondary cataract may develop. If adhesions persist in spite of treatment, they appear to assist in producing relapses, which, however, are very exceptional after syphilis, very common after rheumatism. Occasionally, at the same time as the iritis, but generally a few months later, an attack of *retinitis* or *choroiditis* is liable to occur. The symptoms are more or less rapid failure of sight, with muscæ, the diagnosis being made certain by the ophthalmoscope. This form of retinitis is frequently attended by some opacity of the vitreous. In both, the prompt use of mercury to ptyalism is urgently demanded; and since everything depends on a rapid effect, inunction is of especial value.

The mucous membranes in the secondary stage.—The chief secondary lesions of the mucous membranes are symmetrical, horse-shoe, or kidney-shaped ulcers of tonsils, ulcers of the soft palate, pillars of fauces, palate, inner surfaces of the cheeks (especially at the angles of the mouth), and the tongue. Patches may form in these situations of raised, congested, and abraded mucous membrane, to which the term *mucous patches* is applied. On the tongue the papillæ may be atrophied, producing bald areas, or they may be much hypertrophied; this especially occurs along the middle of the dorsum. Smokers, and those addicted to spirits, or having sharp teeth, will probably suffer the most severely from all these affections of the mouth. In their treatment a solution of chromic acid (ten to twenty grains to the ounce) is a valuable application. At the same time that the mouth suffers the other mucous orifices are very likely to be affected. On the vulva in women, around the anus in both sexes, and under the prepuce in men, mucous patches, condylomata, and warts, are very frequently seen. Secondary ulcers and condylomatous growths occur sometimes in the rectum, and may then be the origin of stricture.

Affections of bones and joints in the secondary stage.—Periostitis is common, and differs from that occurring in the tertiary period, in that it is usually slight in degree and transitory.

Considerable pain may attend it, and there may be tenderness and slight swelling over the part complained of; but definite "nodes" are very exceptional. The pain is usually worse towards night-time, and is remarkably amenable to mercury, in some cases best given with iodide. However, even if untreated the secondary bone and joint affections may pass away and leave no permanent results. It is to be noted that those bones most usually involved, the tibiæ, the skull, the ribs, etc., are precisely those most prone to suffer later on. The tendinous sheaths and joints are sometimes affected, and the symptoms may closely resemble and be mistaken for those of rheumatism.

The ear.—Not a few patients during the secondary stage of syphilis become a little deaf in one or both ears; in most cases only for a short time. In exceptional cases, however, absolute deafness is rapidly produced, and nothing but the vigorous use of mercury can save the function from becoming permanently lost. Menière's disease is now and then closely simulated.

Alopecia.—It is well known that the hair is often affected; complete baldness is rare, the usual condition being a general thinning over the whole scalp, which lasts for a short time, and then, as a rule, leaves no trace behind. There may also be slight, or even severe, disturbance of nutrition of the nails, or inflammation at their margins.

Less frequent phenomena of the secondary stage.—Between the toes, or in the neighbourhood, superficial (often linear) ulcers may form, which were formerly known as *rhagades*.

Very occasionally, about the time of the iritis, symmetrical, almost painless, *epididymitis* is met with, especially involving the globus major; or the testis itself may swell.

The *general health* suffers in a large proportion of cases, one of the commonest symptoms being anæmia.

The red blood corpuscles have been proved to be diminished in number in these cases, and to increase again when mercury is given, so that the latter has been well termed the "iron of syphilis." It is, however, often desirable to prescribe some preparation of iron with the mercurial, ferrum redactum being one of the best.

General glandular enlargement is very frequent, but since it may be only slight in degree and quite painless, the patient will not complain of it. The medical man, however, will often readily detect it in such situations as the inner side of the elbow joint (above the epicondyle), the back of the neck, and the groins. In strumous subjects these glandular swellings may prove most obstinate, and may even suppurate, but quiet resolution is the rule. The spleen and liver may be noticed to be slightly swollen for a time, and temporary albuminuria is not unknown.

The *nervous system* is sometimes peculiarly affected during the secondary stage in women. Loss of appetite, muscular weakness, insomnia, neuralgia, and headache, are common. M. Fournier has pointed out the occasional occurrence of anæsthesia and analgesia on certain parts of the body, especially the backs of the hands and feet, and the breasts. Although common in women, symptoms of vague nerve disturbance are not very infrequent in men.

General emaciation is sometimes met with, and in cases in which specific treatment has been irregular and hygienic measures wholly neglected, a true syphilitic *cachexia* may arise, the patient becoming extremely thin and weak, the skin of an earthy hue, the eruptions tending to ulcerate freely, and the system becoming predisposed to the onset of phthisis, etc.

Treatment of the secondary stage.—With regard to affections of the eye, severe skin eruptions, or bone pains, etc., there is now no question that mercury is the great remedy, and that it should be given freely until the symptoms are relieved. If soreness of the gums or slight ptyalism is produced, no harm is done. Sedulous attention to cleaning the teeth will usually prevent it; or, at any rate, the use of chlorate of potash gargles, and the diminution of the dose, will prevent any bad effects. Whilst a few still teach that a prolonged course of mercury has no effect in preventing or lessening the dangers of tertiary syphilis, there is very strong evidence to support the opposite view. In a matter of such importance, it is certainly the medical man's duty to prescribe mercury for a very considerable time, using small doses, interrupting the course from time to time, and employing every means in his power to keep up the general health of the patient. The abuse of alcohol certainly destroys the good effects of mercury. Every article of food which is likely to cause diarrhœa should be carefully avoided, such as fruit, green vegetables, and coffee. Opinions differ as to the requisite length of time for treatment, six months to two or three years being the limits. One grain of mercury and chalk, with one of Dover's powder, may be taken every four hours for long, and is, perhaps, the most convenient form. The perchloride, given with iodide of potassium, is a favourite preparation in the treatment of later syphilitic phenomena. If mercurial inunction is applied, care should be taken to avoid hairy parts and those covered with a thick epidermis. The mercurial bath is of use in treating severe skin eruptions. Hypodermic injection of a mercurial has several drawbacks, and little to recommend it.

The intermediate stage.—Between the disappearance of symmetrical secondaries and the commencement of the tertiary stage, the patient may be said to pass through an intermediate one, during which certain symptoms are liable to occur, which may well be termed reminders, as well as partial relapses of his former ones.

The most common are certain affections of the skin, the tongue, and the testicle. Their features are the following: sometimes symmetrical, at other times not so; some of them disappear without specific treatment, whilst most probably do not. The term "reminders" has been well applied to them, since they may appear at such a space of time from any other symptoms, that the patient believes himself to be free from his former disease. Local causes, such as irritation, have sometimes a considerable share in their production, and when they develop, their subject is probably ceasing to be a possible conveyer of contagion to others, his offspring excepted. Thus they may fairly be contrasted with the phenomena of the tertiary stage, which are almost always non-symmetrical, show no tendency to spontaneous cure, and occur at a time when contagion is probably impossible.

It is difficult to assign any definite *period* of time to the intermediate stage. Some of its symptoms may appear to belong to a protracted secondary, and others to a premature tertiary one. The term is, however, still a very convenient one by which to denote the feebly-marked and often transitory symptoms which often shew themselves during the long interval between well-defined secondary and tertiary phenomena.

Peeling patches in the palms furnish one of the best examples. They are more common on the right than on the left side, no doubt owing to their localisation by the irritation of pressure. They show little tendency to the scale-accumulation, which their name (psoriasis palmaris) would indicate. The same term is applied to a distinctly tertiary serpiginous affection, which is attended by a dusky thickened edge. It may here be noted that it is quite erroneous to imagine that all cases of "psoriasis palmaris" are syphilitic.

Syphilitic affections of the testicle are seldom seen either in the early secondary or late tertiary stages; they belong, as a rule, to the intermediate group. The most common condition is a general, slow, painless enlargement of the whole gland; sometimes there are distinct masses of deposit in the epididymis. Abscesses may occur if no treatment is resorted to, and these may lead to fungus testis. The other results of a syphilitic testicle are: (1) Complete resolution under treatment; (2) fibroid thickening and induration with or without (3) atrophy of the gland. The diagnosis may often be made from the large size, peculiarly rounded outline, loss of testicular sensation, and light specific gravity. A gumma of the testis feels decidedly lighter in the hand than either a hæmatocele or a malignant growth of the same size. Under the influence of mercury and iodide of potassium, the largest and most threatening forms of sarcocele will usually subside, and excision is very rarely justifiable. Relapses after cure are, I think, not common. (*See* Art. XI., vol. iii.)

Choroiditis, etc.—It is during this intermediate period that choroiditis, if it occur at all, is most likely to happen. Sometimes distinct gummata may be demonstrated by the ophthalmoscope; generally patches of thinning and absorption of the choroid are discovered without evidence of previous gummata. Inflammation of the retina or optic nerve may occur at the same time or alone. Very often only one eye is affected, and the attack is quite transitory.

Syphilitic disease of arteries.—Inflammation of either the internal or external coats may occur in any artery of the body, but their results have chiefly been studied in the brain. The middle coat, as a rule, escapes. There are no special characters by which the syphilitic form of arteritis can be distinguished from the others, if we except the general fact that the cell effusion is usually excessive in syphilis. Either narrowing of the vessel, ulceration of its inner coat, formation of emboli, thrombosis, or aneurism, may result. Cerebral disease, consequent on disease of the walls of the vessels, is a very distinct affection from the other brain and nerve lesions which occur from syphilis. It almost always assumes somewhat of the nature of a "fit." The arterial condition being one of thrombosis, not of laceration, it follows that the paralysis (usually hemiplegic) comes on somewhat gradually, and not suddenly as in hæmorrhage. As the vessel becomes more and more nearly occluded, the patient experiences tingling, or twitching, or weakness in the limbs about to be affected, and this may last some hours before all power is lost. Now and then, however, the seizure is very sudden. A considerable amount of recovery may be confidently expected, but it will seldom be quite complete. (*See* Art. XXVI., vol. i., p. 384.)

The "intermediate" phenomena seen on the *tongue* consist chiefly of small non-symmetrical superficial ulcers or bald patches, of the white raised patches called leucomata, or of warty growths. The influence of local irritants, especially hot tobacco-smoke, in producing these lesions is well marked.

On the *skin* rings of erythema are noticed from time to time, especially on the arms and trunk, exposure to heat or cold often causing them to appear.

Rupia is sometimes found so late as to be fitly placed in the intermediate group, though, on the other hand, it may result from any secondary eruption in an unhealthy subject which has gone on to ulceration.

The tertiary stage.—After, it may be, a long interval of good health, and at a period of from five to ten or even twenty years from infection, the syphilitic patient is liable to true tertiary symptoms. They are mostly due to gummata or to chronic inflammatory thickening; frequently the latter is a result of the slow absorption of the former.

Almost all the morbid processes which occur in this stage are locally infective, and thus spread serpiginously. They show no tendency to spontaneous cure. In these two features they differ much from what is usual in the secondary stage.

By the term **gumma** is meant a mass of cells, which at first resembles granulation tissue, tending to infiltrate the surrounding structures, and also tending to break down in the centre by fatty degeneration or necrosis. In the viscera they commonly (especially under treatment) are slowly absorbed, leaving perhaps extensive scarring (as in the liver); but a gumma, having become firm and leathery, may persist in this state almost indefinitely. When situated in the subcutaneous tissues a gumma tends to slough and come away through an aperture in the skin, and here a typical "wash-leather" mass is often seen lying in a suppurating cavity.

It is to be clearly understood that gummata may occur at any stage of syphilis. There is nothing in the mode of its formation or tendencies to distinguish a primary induration from a gumma; and the same remark applies to many forms of secondary inflammation. The largest and most characteristic gummata are, however, met with in the tertiary stage.

The following are the chief phenomena of the tertiary stage.

1. **Chronic and relapsing periostitis**, leading to osseous nodes or sclerotic hypertrophy, but if neglected to suppuration and necrosis. Any bone in the body may be involved, but a decided preference is shown for those of the skull and the tibiæ. The affection is rarely multiple or symmetrical, and if treated early it yields with surprising ease to iodide of potassium. This holds good whether the node appears

so hard as to suggest new bone formation, or has softened so much as to threaten suppuration and ulceration. A dull aching pain nearly always accompanies the periostitis, a pain which becomes worse towards night.

On the skull vault nodes are very common, especially on the forehead, and necrosis of parts of the outer table may result, abscess between dura mater and bone occasionally being met with, new bone being very rarely found (this applies to the acquired disease only). The nasal septum and the delicate turbinated bones are also very prone to necrose, and hence occurs sinking in of the bridge and ozæna. Perforation of the palate is generally syphilitic. Gummata have been found within the vertebral bodies and on the inner surface of the cranium or spinal canal, but they show a preference for the exposed surfaces of superficial bones. (*See* the article on Diseases of Bones; vol. ii., page 134.)

2. **Gummata in viscera, especially the liver, testis, and lung.**—In the liver they are commonly accompanied by interstitial hepatitis, which, indeed, may be alone present. Post-mortem evidence generally reveals the existence of firm leathery masses with deep puckering of the surface. Amyloid degeneration, too, is sometimes a result of tertiary syphilis, more especially if slow suppurating inflammation of bones, etc., has been set up by the latter.

The diagnosis of syphilitic disease of the liver is by no means easy. Jaundice, ascites, epistaxis, melæna, etc., may be caused by it; but there is, of course, nothing in these symptoms to point to the origin of the disease. Considerable increase of the liver dulness, with perhaps the detection of a puckered edge, is sometimes met with, and may be followed by cirrhosis and consecutive atrophy. Great enlargement of liver and spleen is more often seen in inherited than in acquired syphilis.

The symptoms and diagnosis of specific disease of the *testis* have been already described. It may be added that the cord and epididymis are, as a rule, normal, at any rate at the onset of the affection.

Syphilis is only known for certain to attack the *lungs* in its tertiary stage, and here, just as in the liver, both gummata and interstitial fibroid changes are met with. For some time no symptoms may be present, and as the ultimate result (apart from treatment) is usually the same as in tubercular phthisis, it is no wonder that the disease is liable to be overlooked or mistaken. Help in the diagnosis is obtained by remembering that syphilis shows no such preference for the apices as does common phthisis; that the larynx is often affected; and that an energetic specific treatment will probably result in decided improvement. The microscope may also aid the diagnosis in a negative manner.

I have described a case of a man who died suddenly from intestinal obstruction, in whom the post-mortem revealed gummata in both lungs and testes.

3. **Gummata in the fibrous and cellular structures throughout the body.**—The meninges of the brain and spinal cord, the capsules of joints, and the subcutaneous and submucous tissues, are the parts most commonly affected. In the brain substance gummata seem never to commence, but it may be invaded from the membranes. Thickening of the meninges is a frequent companion of the syphilitic tumour, or may alone be present.

The chief symptoms of either are (1) persistent and severe headache, often paroxysmal, and preventing sleep; (2) convulsions like those of epilepsy, but commencing at a later period of life, sometimes confined to one limb, and frequently accompanied by optic neuritis; (3) paralysis of one or more cranial nerves, especially the oculo-motor ones; (4) hemiplegia.

The last named has been already alluded to as resulting from plugging of one of the cerebral arteries due to syphilis, and it may be added that small aneurisms, due to the same cause, have been found on many of the cerebral vessels.

It is very common, especially in women, to see scars about one or both knee joints, the signs of former gummata. Together with the presence of these in the aponeuroses and capsule of the knee, there may be synovitis, much resembling the pulpy or "strumous" variety, the periosteum of the bones forming the joint being at the same time involved. Commonly the gummata burst externally, and before they do so the surrounding skin may be much inflamed and thickened. Other joints than the knees are liable to be affected.

The intermuscular septa, the tendons (particularly the tendo Achillis and others about the ankles), and the bursæ are not very uncommon seats for gummata.

Beneath the skin in both arms and legs, multiple, firm, painless lumps are occasionally seen, which, there is good reason to believe (chiefly from their subsidence under treatment, and the history of syphilis) are gummata developed about veins or lymphatics. They tend to become adherent to the skin, and sometimes by their confluence form a large cake-like mass. In the legs some of the most troublesome ulcers we encounter are the result of periphlebitic gummata.

The diagnosis of tertiary syphilitic ulcers.—This is sometimes a matter of great difficulty; at others it will be rendered an easy task by recalling the following considerations: (1) A gummatous ulcer should be preceded by a firm lump, which softens and then "breaks," instead of starting as a small pimple or directly following a wound or severe contusion, as so many non-specific ulcers do. (2) If seen early, a white or greyish-white slough is observed within a cavity having inflamed walls. (3) The edges of a specific ulcer tend to be rounded and sharply cut, sometimes as though with a punch. (4) Position is sometimes a valuable test, the region of the inner malleolus, the lower third of the leg, and along the crest of the tibia, being favourite seats of non-specific ulcers. Syphilitic ones are frequently found in the upper third or over the calf. (5) In all doubtful cases the rest of the body should be examined, and indirect questions as to a syphilitic history are often of value, although it is possible for the answers to mislead.

It happens not infrequently that specific treatment effects alike the cure and the diagnosis. (*See* Art. v., vol. i., page 73.)

4. **Diseases of the skin of a lupoid type, gummatous or tubercular in commencement, serpiginous, and leaving scars.**—A common late syphilitic eruption is one especially met with on the face, in which a number of red-brown or brown tubercles appear on the forehead or margin of the nasal orifice, or on either lip. Small scab-covered ulcers, and finally superficial scars, are the usual results. These copper-coloured tubercles about the nose, having a very slow course if untreated, are very characteristic of syphilis.

Syphilitic lupus may occur on any part of the body, and the diagnosis from the non-specific form is sometimes very difficult. The presence of a considerable number of isolated patches, or of spots of another sort of eruption (*e.g.* palmar psoriasis or rupia), deep pigmentation, the late period of life at which the disease first showed itself, and the absence of any semi-transparent deposit like apple jelly, are points in favour of syphilis. It must be remembered that the test of specific treatment will not always decide the matter, since syphilitic lupus may resist for long either mercury or iodide, or may yield to a short course of the former after large doses of the latter have been tried in vain. If, however, the patch be once cured, it will probably not return, unlike the true lupus. Much destruction of tissue, especially if the nose be affected, is sometimes the result. Local treatment with iodoform is of great value, and often suffices; but the acid nitrate of mercury may also need to be applied occasionally, especially if the surface is unbroken.

Amongst the most serious results of syphilis are *serpiginous ulcerations* at either end of the alimentary tract, *i.e.* the pharynx and rectum. Stricture is very prone to follow; indeed, it is probable that most cases of non-malignant stricture of the rectum are due to syphilis. Fatal hæmorrhage has followed in a few cases of syphilitic ulcer of the pharynx. By the time a cicatricial stricture has formed, "specific" treatment is, as a rule, of little avail, but it should always be tried. The œsophagus is comparatively very rarely attacked, but any part of the larynx, particularly the upper aperture, is liable to ulceration and stenosis. It is in severe cases of this sort that tracheotomy has been most successful, and it may become urgently required for those in which œdema glottidis suddenly complicates any syphilitic lesion of the larynx.

5. **Diseases of the tongue of a gummatous or simply inflammatory form; in either case leading to sclerosis.**—These conditions may vary from one or more fine scars or bald patches to deep furrows traversing the dorsum, which latter may then have entirely changed from its normal appearance and become a series of irregular bossy elevations. Fissures and ulcers are a frequent and troublesome accompaniment. In their local treatment all irritants (such as smoking) should be forbidden. A solution of chromic acid, ten grains to the ounce, may be painted

every other day over the sores; but the most efficient measure is to touch them freely not oftener than once a month with the acid nitrate of mercury.

The diagnosis of tertiary ulcers of the tongue is a matter which is frequently of great importance, particularly when there is a suspicion of cancer. If an ulcer be carcinomatous, the surgeon must, if the diagnosis is to be of use, form his opinion before such signs as glandular enlargement and fixation to the floor of the mouth have made it easy. (*See* Art. II., vol. iii.)

Gummatous ulcers are usually preceded by a lump; they may occur at any part of the tongue (but frequently towards the middle of the dorsum), are not rarely multiple, frequently cause but little pain or salivation, present little "growth" or induration at their borders, and may be met with in early adult life.

Epithelioma of the tongue especially affects the borders, is practically always single, is often accompanied by shooting pain in the ear, with salivation and foul smell, has a hard and raised or warty edge, and begins, as a rule, in men between forty and sixty. Mr. Butlin and some good authorities attach importance to the microscope test. The scraping of a specific ulcer shows pus and blood cells, etc., with perhaps a little normal epithelium, whilst that of a cancerous one will exhibit epithelial cells differing much in size, some with large nuclei, and perhaps cell nests. The ulcer should be cleaned before the test is applied, and the scraping taken from its deepest part. If, however, the ulcer is sufficiently suspicious to cause anxiety to an experienced surgeon, it will be wise to cut it out irrespective of the evidence of the microscope.

The permanent white patches known as *leucomata* may result from syphilis, but by no means from this alone; and there is no doubt that many of the affections of the tongue formerly ascribed to this cause are often largely or entirely due to the habit of smoking.

There is now no question that a syphilitic tongue (if deeply scarred or frequently ulcerating) is prone to develop into carcinoma, and if there is the least fear of this having occurred it is well to advise excision of the affected part.

6. **Muscular nodes or gummata in the substance of muscles.**—These often, by their absence of inflammation and comparatively slow growth, simulate tumours. They frequently occur close to the bony insertion of the muscle, and may appear very hard, may cause gland enlargement, and in a few cases may resist for some time the usual specific treatment. Diffuse infiltration of a muscle may also result from syphilis, and cause atrophy or permanent shortening.

The great pectoral, the deltoid, sterno-mastoid (especially in children with inherited syphilis), the orbital muscles, and those of the abdomen and legs have been, amongst others, known to be affected. Since there is no conclusive diagnostic sign the effect of antisyphilitic treatment should be tried for a time in any doubtful case. Gummata have frequently been cut down upon in the belief that they were tumours, and even amputation has been performed.

7. **Aggressive structural disorders of the central, conductive, or ganglionic parts of the nervous system,** leading to such affections as ataxy and its complications, ophthalmoplegia externa and interna, general paralysis of the insane, amaurosis from atrophy of the optic nerve, paralysis of special nerves (the fifth, the facial, etc.).

In most of these there is not at any stage evidence of active inflammation, nor is there any proof of deposit or growth which might deserve the name of gumma. No doubt a very chronic form of inflammation is at first present, but it gives place quickly to atrophic changes. There is every reason to believe that the initial disease is serpiginous, or locally infectious, for we find it slowly spreading to adjacent parts unless arrested by treatment, by which these affections are, however, much influenced only in their early stages.

With regard to these nervous diseases the student must be referred to other authorities (such as Dr. Gowers, M. Fournier, etc.). It may, however, be explained that by *ophthalmoplegia externa* is meant partial or complete paralysis of the oculo-motor muscles, leading to more or less symmetrical immobility of the eyes, with drooping of the upper lids. It depends on degeneration of the nuclei of the third, fourth, and sixth nerves, and in several cases has been accompanied by optic atrophy, ataxia, or other nervous disorders.

Ophthalmoplegia interna implies paralysis of all the muscles within the eye, so that the pupil is immobile, and the patient cannot accommodate. It may be only partial, and may affect one or both eyes. Some cases (like those of ophthalmoplegia externa) have been considerably improved by the treatment appropriate to tertiary syphilis. Both affections are rare.

8. **Chronic inflammations of mucous membranes in certain regions,** attended by thickening and ulceration. These occur especially in the rectum, pharynx, mouth, and female genitals; and have already been alluded to.

Treatment of tertiary syphilis.—The prognosis here depends wholly upon the success or otherwise of our treatment, for the nature of the affections of this stage is to be progressive, and to show no tendency to spontaneous cure. Iodide of potassium, given in sufficient doses, is usually very successful. Three grains three times a day is the usual dose to commence with, given with three or four grains of carbonate of ammonia, and freely diluted. If the patient shows no idiosyncrasy with regard to the drug and the cure does not advance, the dose should be increased, two grains every fourth day until it reaches a scruple; and in these very minute ones will often effect the same good results as the largest in others. A third of a grain three times daily may be sufficient. In a few cases enormous quantities, such as an ounce or an ounce and a half, have been taken daily with benefit. In many instances, however, even small doses depress much. Whenever a case resists the iodide, and whenever it is important to obtain a rapid result, mercury should be combined. Often when once a complete local cure is obtained no relapse whatever occurs, and the patient will remain well for many years. Some tertiary symptoms, however, progress steadily in spite of treatment, or relapse very speedily when it is suspended. In many a distinctly beneficial influence is secured, but nothing like a cure effected. Especially is the last statement true concerning many of the affections of the nervous system which are remotely connected with syphilitic taint. Thus the non-success of treatment can by no means be accepted as conclusive in regard to diagnosis. Speaking generally, the gummatous lesions are the most amenable to treatment; the degenerative, or those due apparently to chronic inflammation which has persisted a long time, the least so.

If the modern practice of giving only very small doses of mercury be followed it will often be found that it depresses far less than the iodide, and is at least equally efficient. There is a general impression that cures by mercury are more stable than those of iodide. It may be doubted whether such is the fact. Whichever specific we use, the point is to effect a complete local arrest of the morbid process. If that be done relapses are probably exceptional.

Tonics, good diet, cod-liver oil, sea air, the avoidance of fatigue and excitement, etc., are useful aids to the specific drug treatment. Sarsaparilla is still sometimes ordered, apparently with advantage. Iodoform for superficial tertiary lesions has almost superseded other local applications. It may be diluted with subnitrate of bismuth or used in an ointment.

It will be understood, from what has been advanced, that the diagnosis of tertiary syphilis is often beset with difficulties. As in the earlier stages, we still find the disease playing the part of an imitator. It may be said in general that suspicion should be aroused whenever a chronic malady is irregular in its development and course. The syphilitic imitations are seldom quite perfect, and they often develop much more rapidly than do their prototypes. In all such cases the history must be carefully inquired into, and upon it the diagnosis must in many cases depend. But in many cases of gravely suspicious lesions where a history of syphilis is wanting, it is most advisable to give the patient the chance of a successful result from specific treatment.

Inherited Syphilis.

It is almost certain that a man with syphilis can transmit the disease to his offspring through the spermatozoa; it is also certain that a syphilitic mother can do the same either through the ovum or through the placental circulation. By means of the latter, a fœtus may probably be infected up to a very late period of gestation. A large number of children with inherited syphilis develop their secondaries about a month after birth, often having presented nothing to distinguish them from perfectly healthy infants until this date. There is probably no disease which predisposes a woman to abort so frequently as does syphilis, whilst it is quite possible that the embryo or fœtus may appear healthy. On the other hand, the death of the fœtus from intra-uterine syphilis may be the cause of its premature expulsion. If a woman is known to be syphilitic during pregnancy, specific treatment should be carefully adopted with a view to prevent abortion or the transmission of the disease to her offspring. A parent may transmit syphilis to a long series of children, and it is not infrequent to get the following history: two or three abortions, then the birth of a dead infant at full or nearly full term, then a child dying from severe secondary syphilis at the end of a month or two, finally children attaining adult age, but revealing their inheritance by disease of the eyes, the bones, etc.

Supposing that the child lives, it may be well developed and show no signs of disease for from one to two months. Then an outbreak of most characteristic symptoms occurs. The infant snuffles in breathing, owing to persistent inflammation of the nasal mucous membrane. The latter, being contiguous to the periosteum of the immature nasal bones and septum, disturbs their development; hence arises the well-known nasal deformity, a sunken and wide bridge.

A papular, blotchy or scaly rash then follows, the angles of the mouth become inflamed (leading to radiating scars), and mucous patches are found inside the mouth with or without a general stomatitis. The commonest eruption is an erythematous or papular one, but pustular or even bullous forms are not infrequent. The gravity of infantile pemphigus has been alluded to. It is probably in all cases syphilitic, and is usually followed by marasmus and death; but, curiously, at the time the eruption appears no other confirmatory symptoms may be present; this may be due to its onset within a week or two of birth.

The genitals, the groins, the buttocks, backs of thighs, palms and soles of feet, are favourite seats for inherited syphilitic eruptions, lines of ulceration or condylomatous growths being often seen at the anus similar to those met with about the mouth. Much scaling is rare, but the lean-ham colour is often extremely characteristic. Ulcers leaving scars are met with on the buttocks, thighs, etc., but they usually appear some months later than the secondaries already enumerated. As in acquired syphilis, the hair and sometimes the nails suffer, and if the eruption has been general and severe, the skin may remain dry and of an earthy hue.

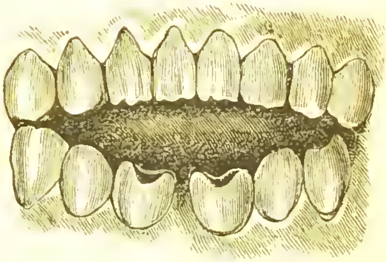

Fig. 8.—Teeth in Hereditary Syphilis.

Condylomata are noticed from time to time during the first year or two, especially on the scrotum or about the anus.

The importance of the stomatitis, slight though it may appear at the time (it is often described as "thrush"), lies in its influence upon the dental sacs. At the time the inflammation of the gums occurs (one to two months after birth) the temporary set of teeth are advanced in calcification, hence they can hardly become misshapen by it, but may necrose or decay earlier than is usual. The sacs for the permanent teeth are also formed whilst these teeth are yet soft, and some of them are very near the surface, particularly the anterior molars and the median incisors. Their cutting edges are, of course, most superficial, and this may explain why the characteristic defects are shown chiefly or entirely at this part. These consist in either a dwarfing of the whole tooth, an extreme diminution of its free end, or (what is most typical) a certain amount of narrowing of the cutting edge with a central notch or crescent. This is best seen in the upper median incisors, but it may be observed in the lower ones or in the lateral incisors. Occasionally some of the crowns of the temporary teeth exfoliate during the stomatitis, and even a piece of the jaw has been known to necrose. It may be noted that if mercurial defects are present with syphilitic ones, which is exceedingly common, they may be distinguished by the horizontal defects in the enamel, mercury alone never producing a vertical notch.

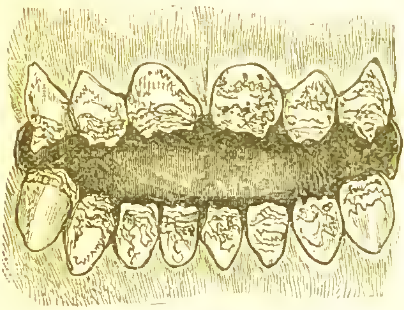

Fig. 9.—Mercurial Teeth.

Iritis or choroiditis may occur with or soon after the eruption, cerebral meningitis and arachnitis also being fairly frequent, the latter leading to hydrocephalus.

Diseases of bones, etc.—A peculiar form of periostitis or ostitis is frequently present; it can best be detected on the cranial vault and near the joint ends of long bones. In the former it leads either to elevations on the surface or to thinning of the bone (the so-called cranio-tabes), and both often co-exist. *Cranio-tabes* is characterised by a peculiar crackling, or an abnormally soft spot being detected on pressure, and it is (as shown by Drs. Barlow and Lees) often associated with inherited syphilis. In the production of cranio-tabes, pressure both from within and without the skull probably plays a great part. When it commences after birth it is commonly most marked in the occipital bone, where the weakly syphilitic child would rest its head against the nurse's arm, etc. (Barlow). It has been rarely noticed as a congenital condition (Parrot), but usually commences between the third and twelfth months. It is probably often a result of rickets, and only when combined with persistent deposits at other parts is it to be considered as indicating syphilis.

A peculiar form of chronic inflammation or softening occurs at or just above the epiphysial

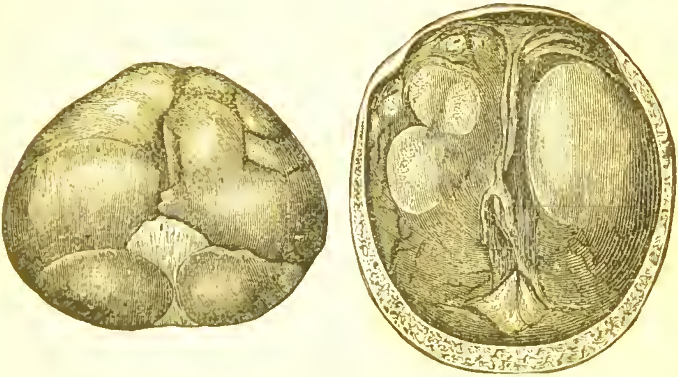

Fig. 10.—Skulls showing Changes due to Hereditary Syphilis. (After Barlow.)

cartilages, sometimes leading to the detachment of the epiphyses, at others to their premature union with the shaft, and occasionally to suppuration. The partial resemblance to rickets of these changes will be noticed. Whilst these symptoms are progressing the infant often becomes thin and cachectic, the liver and spleen may enlarge, occasionally jaundice follows, and amongst the poorer classes death frequently ensues. If, however, the child recovers, after a few months' time all symptoms may disappear, and even until puberty no fresh ones may show themselves. This rule is, however, by no means invariable; for in the interval nodes may appear on various long bones (especially the humeri and those of the leg), and occasionally great enlargement of the viscera (liver and spleen). The nodes are usually symmetrical, may produce elongation of the bone, as well as the appearance of curving, if only one is affected, and tend either to sclerosis or to very obstinate caries, usually combined with formation of new bone. The radii and ulnæ are not infrequently affected. (*See* Art. II., vol. ii.)

Affections of the nervous system, etc.—Mental defect (amounting sometimes to idiocy) and a few other nervous diseases are occasionally met with, and chronic non-tubercular meningitis sometimes proves fatal.

Between the ages of five and thirty, but usually near to the period of puberty, inherited syphilis reveals itself in the eyes and auditory apparatus, in the form of interstitial keratitis and deafness. Both are, as a rule, symmetrical, but the symmetry is not always simultaneous. One eye is very often affected before the other, exceptionally even months or years intervening.

Interstitial keratitis usually begins by a patchy or diffuse cloudiness of the corneal substance, ulceration of its surface being absent throughout. The clouds increase and coalesce until the whole cornea looks like ground glass; there may, however, be a comparatively clear margin. There is now almost always a zone of ciliary congestion, and more or less intolerance of light, with pain round the orbit, vision being for the time extremely bad. The development of fine vessels in the cornea sometimes produces pink or salmon-coloured patches, which are very characteristic. However severe the attack, the patient may be encouraged to hope for a slow but steady improvement; but restoration to perfect vision should not be promised, although it frequently occurs. The duration of these cases is very unequal. I have seen the cornea clear within two months; more frequently six or eight elapse before fair transparency is restored, and in many cases gradual improvement goes on for a year or two. The influence of a prolonged and mild specific course is of marked value. It is difficult to tell the condition of the iris when the cornea is hazy throughout, but if iritis is suspected it is well to use atropine occasionally. A few cases have, however, been noticed in which permanent dilatation of the pupil has followed its prolonged use in this disease. Myopic astigmatism, owing to yielding of the softened cornea, is a not infrequent result. The student cannot too carefully study the diagnosis, which may require to be made from pannus (due to granular lids), from ulceration of the cornea with much vascularity, and from keratitis due to small-pox. The incisor teeth test, the ground glass conditions and salmon patch opacities, the tendency for both eyes to be involved, the slow progress of the disease, and confirmatory evidence in the patient's face or family history, are of most importance. Pannus usually begins and is most marked in the upper segment of the cornea. Rarely, a relapse occurs in one or both eyes, several years after the first attack.

At the same time as the keratitis, the patient often suffers from chronic synovitis of one or more joints, usually the knees. Almost invariably the effusion (which may be free but painless) disappears after a few weeks.

Periosteal affections of the long bones are at this stage not uncommon, may produce numerous and large nodes, and if near to joints may cause much crippling of movements. If situated on the shaft the bone appears curved; in former times this was often mistaken for rickets. Over-growth in length as well as thickness of the bone is almost constant, and it may attain an inch or more. The skull rarely suffers with the long bones. If suppuration occurs the exposed bone is not enclosed by any new shell, and is extremely slow to separate.

The mucous membranes, the viscera, and the nervous system appear to be almost exempt from specific lesions at this stage. A few cases of epilepsy, paraplegia, ophthalmoplegia, and of certain other nervous diseases have been recorded, which were due to inherited taint, but they are decidedly exceptional.

Children with inherited syphilis are not subject to the same relapses of skin eruption that adults with the acquired disease often present, but a disease somewhat resembling a destructive form of lupus does occasionally occur. It sometimes ulcerates so freely as to suggest phagedæna, and the local treatment is of as great value as in the latter disease. Phagedæna may also attack the nasal septum, or the palate, and occasionally great deformity is produced. In such cases the affected surface should be cauterised with acid nitrate of mercury, and iodoform should be freely used; specifics being given internally, and every measure taken to keep up the patient's health. If possible the advantages of sea or country air should be added.

Nodes may occur from congenital syphilis on the phalanges, particularly the first. Syphilitic dactylitis is a form of periostitis and ostitis which may produce great swelling, is most frequently seen at the back of the first phalanges of the hand, and is to be distinguished from "strumous dactylitis" by its yielding to specific treatment.

Many children who have inherited syphilis grow up to be strong and healthy adults. The taint seems to convey no tendency to other diseases, such as scrofula, lupus, and rickets, nor is there the least reason to think that it can be transmitted to a third generation. We see sometimes individuals who are types of good health present in their teeth and eyes the only evidence of their inherited disease.

Visceral gummata, particularly in the testicle, liver, and spleen, have been found presenting conditions precisely similar to those of the acquired disease.

The **diagnosis of inherited syphilis.**—Typically notched and narrowed permanent central incisors, with the remains of opacities in the substance of each cornea, and the history of an attack of partial blindness lasting several months at or near puberty, are as certain evidence of inherited syphilis as can be desired. Radiating scars at the angles of the mouth, unexplained deafness, a depressed nasal bridge, and a horizontal groove above the eyebrows, with a projection of the whole forehead above this, are most valuable confirmatory signs. The history of snuffles or of infantile eruptions, as well as the mother's statements as to her confinements and offspring, should be carefully inquired into.

It should not, however, be forgotten that young children occasionally acquire syphilis in unsuspected ways, as from circumcision, vaccination, kissing, etc. In this way a child may chance to present at an early age symptoms of tertiary acquired syphilis, and the absence of any history of primary chancre or secondaries may throw doubt upon the case. It is not as yet known for certain in what respects the course of syphilis acquired in early infancy differs from the inherited form.

The diagnosis in infancy has already been alluded to, and it need only be added that whilst some of the specific eruptions are very difficult to distinguish from eczema, intertrigo, etc., a definite condyloma can only arise from syphilis.

The bone lesions must be distinguished from those of rickets by the greater tendency to thickening around the bone, and to inflammation at the epiphysial lines, as well as from the absence of night-sweats and beading of the costal cartilages. Of course there is no reason why rickets and inherited syphilis should not co-exist, but there is no real connection between the two.

Treatment of inherited syphilis.—For the secondary stage there is no remedy so successful as mercury, and the dangers of iritis, bone disease, etc., compel a resort to this drug. Mercurial inunction is much more applicable in young children than in adults; the Ung. Hydrargyri may be used inside the abdominal band, or rubbed gently in over various parts of the body, ten grains or more being applied every night. Although mercurials in infants are apt to purge, in many cases they may be given by the mouth; one grain of mercury and chalk, with a little Dover's powder, being a convenient form. Under this treatment the infant will generally regain flesh and strength, and its secondaries are influenced with no less happy result than those of the acquired disease.

On no account should a child with congenital syphilis be confided to a wet nurse, as most disastrous results are likely to ensue. Infection of the nurse's nipple, and from this of her own infant, has followed in many cases, and the medical man who has knowingly allowed this danger may fairly be held responsible. If the mother is unable to nurse her own infant, the latter should be reared by the bottle.

It does not seem desirable to continue mercurial treatment long after the disappearance of symptoms, for there is much less tendency to relapse than in adults, and but little evidence in favour of a prolonged course preventing such lesions as keratitis, etc. Besides, there is always the risk of producing mercurial stomatitis, and so damaging the permanent teeth.

Condylomata, or other moist syphilides, are to be treated in the same way as those met with in acquired syphilis.

In respect to the later manifestations of the disease, it is unfortunately true that mercury and the iodides, although valuable, are much less potent than in tertiary acquired syphilis. A case of syphilitic caries of bone may drag on its course until, perhaps, amyloid disease of liver and kidneys supervene, and interstitial keratitis, however treated, as a rule persists for from four to twelve months. Nevertheless, the prolonged administration of one or the other (many prefer both) with tonics should be persevered with, and in the case of the eyes almost complete recovery is common.

Second attacks of syphilis.—It is certainly the rule for a man who once has suffered from syphilis whether inherited or acquired, to be free from risk of a second attack. But a few well-authenticated instances have proved that the immunity may wear out, and that even third attacks of syphilis may occur. In fact, in this as in so many other respects, syphilis resembles the exanthemata, and at present individual peculiarity can alone be assigned as a reason for the exceptions in either case.

The relapsing chancre.—A source of fallacy may here be alluded to. A peculiar induration in the site of, or close to, a former infecting chancre, is occasionally met with some few years after the attack of syphilis, and such cases may wrongly be held to be instances of second infection, especially since the inguinal glands may enlarge. But it is certain that the true explanation is a gummatous infiltration, which, as in other regions, may cause gland enlargement. This is proved by the absence of fresh exposure to risk in most cases, by the induration leading to relapse in the same and other places, and by the complete absence of true secondaries. M. Fournier and the author have particularly drawn attention to this curious affection, which the former has called the "false indurated chancre." Its secretion, there is every reason to believe, is not infectious.

Vaccination syphilis.—It is now admitted that the disease can be transmitted by using even clear lymph from the arm of an infant with congenital syphilis. After the vaccination sore has healed (as a rule), from four to five weeks after the infection, the scar becomes inflamed and indurates, subsequently following the usual course of a hard chancre. It is to be noted that if a number of persons are vaccinated with the same lymph on the same day many of them may escape infection.

The value of early mercurial treatment was well shown in the cases under my observation, numbering about twenty-five.

The vaccinator who proceeds in his duties with the fear of syphilis before him can, probably, incur but little risk in the matter. He will, in the first place, select his vaccinifer carefully, avoiding all children whose parents are not known to him. He will for the most part avoid all first-born children, and wait until, by the development of one healthy child, some guarantee of freedom from taint on the part of the parents has been given. Next to the scrupulous selection of the child from whom to vaccinate, come the obvious precautions of avoiding the use of blood, and of recent exudation from the walls of the vesicle.

CHRONOLOGICAL STATEMENT OF EVENTS DURING THE FIRST YEAR OF SYPHILIS.

On the supposition that no antidotal treatment has been adopted.

1st month	*Date of contagion.*—A little pustule or abrasion, lasting a few days; then healing, and very likely forgotten. Nothing to be seen, or, perhaps, a soft sore secreting pus.

2nd month	An insignificant pimple, or perhaps nothing whatever to be found. An itching red papule, which begins to indurate. Induration increasing. Induration well marked.
3rd month	A roseolous rash; chancre very hard; bullet bubo in groin. A papular, or scaly, or pustular, eruption; sores in tonsils, and other secondary symptoms.
4th month	Rash and other symptoms continued and aggravated. Iritis and retinitis may occur.
5th month	Secondary symptoms continued in some cases, disappearing in others. Chancre and bubo beginning to diminish. Iritis or retinitis may occur.
6th month	Secondary symptoms continued. Repeated crops of eruption. Chancre probably gone. Patient probably quite well in some cases.
7th month	In many cases secondary symptoms continued, but beginning to fade.
8th month	Secondary symptoms slowly diminishing, or, perhaps, relapsing.
9th month	Patient probably well, but possibly still with rash out; liability in some cases to psoriasis palmaris, sore throat, and to irregular eruptions.
10th month	Same as preceding month, but with diminishing symptoms.
11th month	Symptoms diminishing if any have remained.
12th month	In most cases the patient will have been for several months quite well. In a few he will still have sore throat, sores in mouth and irregular eruptions; in rare cases he will suffer severely from all the secondary symptoms.

The stage of latency or of reminders now begins, after which, at an uncertain date, tertiary symptoms may follow.

XXIII. GONORRHŒA.

AUGUSTUS J. PEPPER.

Is gonorrhœa a specific disease?—The following are the grounds upon which those who believe in the *specificity* of gonorrhœa base their conclusion. (1) The urethral discharge is said to contain a micrococcus which is capable of cultivation in foreign media. (2) That the cultivated organism is capable of exciting an attack of purulent inflammation in virgin soil. (3) That the constitutional symptoms, *e.g.* rheumatism, are an indication of a general disease, consequent on inoculation of a specific virus.

But the evidence in the other direction more than outweighs the facts above enumerated; for (1) the presence of micrococci in gonorrhœal pus by no means proves that they are the essential agents of the morbid process. (2) Gonorrhœa does not arise from an invariable cause, for purulent urethritis and vaginitis, the result of impure intercourse, does not obviously differ in nature from cases following mechanical and chemical irritation, or contact with leucorrhœal, lochial, and menstrual discharges. (3) Whatever the cause of the inflammation, the latter may develop the same local and constitutional complications. (4) The discharge, as it issues from the affected mucous membrane, is liable to be impregnated with indifferent organisms floating in the atmosphere. (5) The antiseptic treatment of acute purulent urethritis has not yielded the favourable results that might have been expected had the disease been derived from an indisputably infective source. (6) As stated by White, of Philadelphia, "(*a*) gonorrhœa has no period of incubation. (β) It predisposes to a second attack. (γ) It is associated only with ordinary processes of inflammation. (δ) It may be awakened or reproduced at will and indefinitely."

Varieties of gonorrhœa.—The varieties of gonorrhœa have been named according to (1) the intensity of the inflammation, and (2) some special anatomical feature of the morbid process. When the inflammation develops rapidly with severe symptoms, it is called *acute;* when it is of a milder type, *sub-acute* or *catarrhal ;* and when it is slight and transient, with little or no discharge, *abortive* or *irritative.* In some cases there is a tendency to fibrinous exudation with implication of the lymphatics; *membranous urethritis.* Again, the mucous membrane may be undermined by abscesses, excavated by ulcers, or thickened by granulations, conditions known respectively as *suppurative*, *ulcerative*, and *granular* urethritis.

Acute gonorrhœa in the male is usually the result of pus coming in contact with the mucous membrane of the urethra during impure sexual intercourse. But not unfrequently patients present themselves for treatment in whom there is a profuse discharge, which can be referred only to the irritation from leucorrhœal, lochial, or menstrual fluid. Instrumental irritation, the impaction of a calculus in the urethra, and strong stimulating injections are also capable of setting up purulent urethritis; but the inflammation in these cases is rarely so severe or lasting as when it arises from inoculation in the ordinary way. The surgeon should be on his guard against expressing too confident an opinion as to the causation of the urethritis in any given case.

The symptoms of acute gonorrhœa are actively inflammatory in type, and usually manifest themselves within the first two or three days after connection. They may come on in a few hours, or be deferred for ten or twelve days. The lips of the meatus are puffy and red, and sometimes they show superficial abrasions. The *discharge* is at first bluish-white, then distinctly yellow. It may be tinged with blood, or appear of a greenish hue. *Micturition is painful*, the sensation being as if the mucous membrane were scalded : *chaude pisse.* This is due, in some degree, to mechanical distension of the inflamed tissue ; but the chief causes of irritation are the salts of the urine, for the suffering is greatly relieved by the exhibition of alkalis. There is generally increased frequency of micturition with a certain amount of vesical tenesmus. In the early stages it is probably reflex in its nature, for as yet the inflammation has not extended to the neck of the bladder. *Chordee*, or painful erection, is complained of, and mostly in the night time, so that the patient's rest is much disturbed. The penis is more or less curved in a downward direction, for the rigidity from the inflammatory effusion prevents the corpus spongiosum being distended to the same extent as the corpora cavernosa. By some the chordee is ascribed to reflex dilatation of the vessels ; and by others to spasmodic contraction of the urethral muscles.

There are certain *local complications* during the progressive stage of acute gonorrhœa which are partly due to spreading of the inflammation in the continuity, and partly to inoculation with the acrid discharge from the urethra. They are (1) *balanitis*, (2) *posthitis*, and (3) *phimosis* and *paraphimosis.* The glans penis is of a bright-red colour, and it is not rare for numerous excoriations to appear upon it, so that it looks as though it had been covered with a herpetic eruption, the vesicles of which had burst. The prepuce is swollen so that it may be difficult or impossible to retract it. On the other hand, it may be withdrawn and fixed behind the glans (paraphimosis), in which case it constricts the penis, causing partial strangulation, but never to such an extent as to induce serious sloughing. A furrow of ulceration sometimes makes its appearance at the seat of greatest tension, *i.e.* on the dorsum of the prepuce a little behind the glans; the portion of the prepuce in front of the constriction is marked by a firm œdematous swelling.

In a case of average severity the ordinary symptoms reach their height in about a week. At the end of that period, under proper treatment, they remain stationary for some days, and then the third stage, that of subsidence, begins. With the extension of the urethritis backwards and in depth, other symptoms develop with greater or less frequency. The mucous follicles may suppurate, forming small *circumscribed abscesses;* or pus may collect outside the urethra, and be discharged either into the passage or externally; the latter, which is not a common complication, is very exceptionally followed by *extravasation of urine.* By the implication of the lymphatic vessels, the foundation is laid for further troubles, for the submucous lymph paths are continuous with those of the skin of the penis, and so with the inguinal glands. Gonorrhœal *bubo* is generally situated just below Poupart's ligament at the inner end; and in the majority of cases it subsides without suppuration, but abscess may form in the affected gland or around it (perilymphatic). *Lymphangitis* is marked by induration and swelling along the course of the inflamed vessels.

Cowperitis, or inflammation of Cowper's glands, is marked by one or two rounded swellings (according as one or both bodies are involved) just in front of the membranous urethra. The ducts which open into the spongy portion of the urethra are invaded by the disease, and their orifices are obstructed by the tumefaction of the mucous membrane. Cowperitis may terminate in suppuration. The diagnosis has to be made between it and periurethral abscess, and painful swelling of the prostate. Like cystitis and prostatitis, it is a late complication of the second or so-called "stationary" period of gonorrhœa.

Cystitis happens in about one case in four. Its presence is indicated by a frequent desire to micturate, by pain during and after the act, the last few drops of water being voided with much distress on account of the irritable state of the neck of the bladder. The urine contains a variable amount of muco-pus. The pain in the perinæum is lancinating in character from spasmodic contraction of the urethro-vesical muscles. Reflex pains are often complained of in the hypogastric, inguinal, and lumbar regions. There is more or less tenderness on pressure above the pubes.

Prostatitis is a frequent sequel of gonorrhœa. It is generally associated with some amount of cystitis. The special symptoms of the affection are dysuria, tenesmus, and a feeling of weight and distension in the rectum. Defæcation is very distressing. On rectal examination the gland is found to be enlarged, puffy, and painful to the touch. The entire prostate may be involved in parenchymatous inflammation, but, as a rule, it is the glandular structure that suffers most. The process may resolve completely; subside into a chronic state, or end in suppuration, in which event the abscess usually bursts into the urethra, but it may open into the rectum. The pus should be let out as soon as detected. This is best done by puncture through the rectum, care being taken to avoid the hæmorrhoidal arteries. If the prostatitis passes into a chronic condition the discharge which was originally purulent becomes clear and viscid like white of egg.

It is during the period of subsidence that **epididymitis** usually presents itself. The date of invasion is variable, but from four to six weeks after the incidence of the gonorrhœa may be taken to include the majority of cases. Now inasmuch as it occurs at so late a stage, when the active mischief in the urethra has subsided, it has been referred to *metastasis*, a theory which is scarcely consistent with many known facts relating to the associated pathology of the affection. In the first place the testicle proper is seldom involved. In the second, the spermatic cord is almost always swollen and indurated. Again, the lymphatics of the prostatic urethra are continuous with those of the vas deferens, so that it is by no means improbable that the areolar tissue of the cord and epididymis is affected by a lymphangitis, the glandular element of the epididymis being reached by way of the vas deferens itself. The extent of the latter tube would explain the length of the interval between the time of the acute inflammation of the urethra and its appearance in the epididymis. The epididymitis is not due to reflex irritation of the nerves, for at the time of greatest disturbance in the urethra the epididymis is free from attack. The *symptoms* are swelling, pain, and exquisite tenderness to touch, with redness and œdema of the scrotal tissues, and frequently acute hydrocele of the tunica vaginalis. As before said, the cord is enlarged. Its constituent structures are welded together by inflammatory exudation. The patient's gait is very suggestive. The febrile symptoms vary in degree; the greater the pain, the greater the general disturbance.

Pelvic cellulitis and peritonitis are infinitely rare. The former may arise from extension of suppuration around the membranous urethra and through the prostate. Peritonitis *in the male* as a sequel of gonorrhœa is all but unknown, only a few cases having been recorded.

It will be seen that the complications hitherto described are referable to the genito-urinary passages and contiguous structures. There remain for consideration: *accidental suppurative conjunctivitis; ophthalmia; gonorrhœal rheumatism;* and *acute pyæmia.*

Purulent conjunctivitis is the result of direct inoculation with pus from the urethra. The symptoms develop with alarming rapidity, the whole conjunctiva is enormously swollen, with engorgements of the vessels. The ocular layer overlaps the cornea (chemosis), and the latter soon shows signs of softening and ulceration, partly from the pressure upon it, and partly from the cauterant and infective action of the pus with which it is bathed. The eyelids are red, swollen, and œdematous. Nothing short of early and active treatment offers a chance of saving the patient's sight. Fortunately, both eyes are seldom affected.

Gonorrhœal sclerotitis is a disease of much milder type than the foregoing. It is analogous in its general pathology to the rheumatic affections of the joints, etc., and being a constitutional disorder, both eyes suffer. The conjunctiva is moderately congested. The circumcorneal zone of sclerotic vessels is injected. The iris may be involved. There is pain of an aching character, and some photophobia. The inflammation, though long enduring, tends to subside and resolve. It is peculiarly resistant to treatment, and it returns almost to a certainty with recurrence of the urethritis.

Gonorrhœal rheumatism is described in the article on Diseases of Joints.

Acute pyæmia resulting from gonorrhœa is met with now and again. I have known it end fatally.

Subacute catarrhal urethritis is the form gonorrhœa usually assumes in a second or later attack. The discharge is often profuse, and is readily excited, but the other local and general symptoms are relatively but little marked. The most likely complications are swelled testicle, sclerotitis, and rheumatism; the two latter being almost certainly invoked if they have previously occurred.

Irritative or abortive urethritis.—In this affection the contact with irritant matter causes a sense of heat about the meatus with slight redness and swelling. The discharge, if any, is mucous. The process comes to a natural termination in a few days.

Diagnosis of gonorrhœa.—It is known from *urethral chancre* by the greater diffusion of the swelling; by the discharge being more profuse and less frequently sanguinolent; and by the signs of irritation of a wide tract of mucous membrane. Urethral chancre is mostly found close to the meatus. The diagnosis may be difficult in the presence of phimosis and balano-posthitis. Bubo is not so common as in the case of chancre. Gonorrhœa and chancre may co-exist. *Balanitis*, with or without preputial chancre, may be mistaken for urethritis; but micturition is not nearly so painful, and there is absence of vesical, prostatic, and testicular trouble. Balanitis never causes sclerotitis or rheumatism. Its most common causes are chancre, and irritation from retained smegma, and tight phimosis.

Gonorrhœa in the female is not so serious a disease as in the male, for the urethra in the female is less complicated in its anatomy, and, besides, it is not necessarily involved. It may affect primarily the vulva, the vagina, the os uteri, and more rarely the urethra; and by extension of the inflammation, the uterine canal, the Fallopian tubes, the ovary, and the peritoneum. When the urethra is implicated its course is marked by an indurated cord-like swelling. Micturition is painful, and is accompanied by vesical tenesmus when the bladder is inflamed. The local complications are abscess of the vulva and of Bartholin's glands, bubo, excoriation about the anus and buttocks, and inflammation of the pelvic cellular tissue and peritoneum, with, it may be, metritis and ovaritis. Gonorrhœal sclerotitis and rheumatism occur less often than in the male; and yet it is not improbable that many cases of arthritis in the female, which are ascribed to ordinary rheumatism, are, in reality, gonorrhœal; at any rate, patients complaining of joint troubles are not rarely the subjects of chronic vaginal catarrh. One explanation of the phenomenal sterility of prostitutes is that the Fallopian tubes are obstructed or constricted as the result of gonorrhœa having reached them through the uterus; at the same time, it must be remembered that the ovaries are liable to undergo fibrous induration and fixation from gonorrhœal inflammation.

Treatment of gonorrhœa and its complications.—The principles of treatment in both sexes are: (1) to obtain rest as far as possible; (2) to withhold alcoholic and sexual stimuli; (3) to diminish the acidity of the urine: this is accomplished by the exhibition of alkalies shortly *after meals*; (4) to allay irritation by sedatives applied locally and given internally; (5) to ensure strict cleanliness. In the acute stage, injections, except of the mildest description, are not advisable, and in the male they may be dispensed with. In the female hot water injections (unless the vulva is acutely inflamed, when the introduction of the nozzle of a syringe is too painful) may be used with advantage.

In the declining stage, cubebs, copaiba, or oil of sandal wood, should be given; but inasmuch as their action is not general, but only through the urine, they are useless in vaginitis; and mild astringent lotions should be injected. With proper care a first gonorrhœa will get well of itself, and, in fact, many cases do quite as well without the use of injections. It is my opinion that the discharge is not seldom kept up by the local measures taken to stop it, and that it is by no means rare for a gleet to be traced to the persistent use of strong applications. It does not matter much what form of astringent is employed; tannic acid combined with sedative solution of opium, and sulphate of zinc, with extract of belladonna, are admirable remedies. Strips of boracic acid lint should be placed between the vulva or beneath the prepuce to absorb the discharge, and they should be frequently changed. The patient should be told of the danger of *inoculating the eye* with the gonorrhœal pus. In case of *retention* the urine should be drawn off by a No. 6 catheter, or the bladder evacuated by suprapubic puncture; preferably the former. To subdue *local spasm*, and to prevent or remove *chordee*, it is well to inject morphia into the perinæum, or to give rectal suppositories of the same drug. Belladonna may be added with advantage. At the same time bromide of potassium should be administered in fifteen-grain doses twice or thrice a day, or in thirty-grain doses at bed time. If an *abscess* forms about the urethra, or in the prostate, the matter must be let out without delay. *Cystitis* is best combated by rest, sedatives, and the fixed alkaline carbonates. In severe cases, as also in *prostatitis*, three or four leeches applied to the perinæum will give immense relief. The bowels should be kept gently open.

In the event of *purulent conjunctivitis*, the sound eye must be closed and protected from inoculation, and the affected one treated with powerful astringents (*e.g.* nitrate of silver, twenty to forty grains to the ounce) and constantly fomented. Splitting of the upper lid to relieve tension has been recommended, but it is of doubtful propriety.

Gonorrhœa of other parts than the

urethra and vagina.—Gonorrhœal metritis, ovaritis, peritonitis, and conjunctivitis have been already described. In addition to these it is alleged that the disease may affect the rectum, the nose, the ear, and the mouth; but, to say the least, it is infinitely rare in these situations, and most practitioners have never seen it.

Chronic urethral discharges, commonly known as *gleet*, owe their origin to a variety of conditions, *e.g.* alcoholic and sexual excesses; chronic prostatitis; stricture of the urethra, and the long-continued use of strong injections.

The nature of the discharge will give some indication of the anatomical condition with which it is associated. Thus, when it is very slight and transparent, and is merely the remains of an acute gonorrhœa, it is owing to a relaxed or catarrhal condition of the mucous membrane. In such cases it tends to subside of itself, and at most weak astringent injections are the only remedies required. A profuse purulent discharge with but little scalding, etc., mostly arises from a local granular or superficially ulcerated state of the urethra, especially at the fossa navicularis and at the bulbo-membranous junction. The treatment consists in attention to diet, regular habits, and the internal administration of tonics and cubebs or copaiba. Much good may be expected from the careful passage of large bougies, and from the application of astringents to the affected spots, either in the form of injections, or a shielded point of silver nitrate, or the red oxide of mercury ointment carried in the eye of a catheter.

In a *typical gleet* the discharge is serous or mucopurulent. There is dribbling at the end of micturition, which is prone to be abnormally frequent; and not seldom there are reflected pains in the belly and loins. The usual cause of these symptoms is *stricture* of the urethra, of wider or narrower calibre.

XXIV. TUMOURS.

Henry Trentham Butlin.

Clinically, we understand that a tumour is a new growth, which produces a swelling or enlargement of the affected part of the body; that it has no tendency to undergo resolution or spontaneous cure, and that it is little or not at all affected by medicine. Yet we are forced to admit that there are new growths (tuberculous, lupous, etc.), which are not regarded as tumours; and that some tumours do not produce swelling or enlargement (*e.g.* some withering cancers of the breast, and certain epitheliomas). Among the tumours, too, it is customary to include cysts, whether they are due to the presence of new growth or not. It must therefore be admitted that the manner in which the term is used is, in some respects, very arbitrary.

All tumours originate in the natural tissues of the body, and are probably derived from the tissues in which they originate, for they are composed of elements which resemble those of the tissues, either in their perfect or imperfect and embryonic state. The new growth may, in its course, thrust aside the surrounding natural tissues, or it may infiltrate them. In the former case it remains limited to the tissue in which it took its origin (a fatty tumour in the subcutaneous fat, for example), and is then termed *homologous*; in the latter case it may extend into tissues of many different varieties, and becomes *heterologous*. Homologous tumours are generally innocent; heterologous tumours are generally malignant. Secondary tumours are often heterologous from their commencement, as when an epithelial growth is formed in the interior of a lymphatic gland.

Tumours owe their **origin** to many different causes.

1. Inflammatory new formations are not usually regarded as tumours, yet there can be little doubt that inflammation is a frequent cause of the formation of a tumour.

2. Long-continued irritation, without actual inflammation, may cause the formation of a tumour; *e.g.* the formation of a cancer of the lip from the irritation of a dry and harsh pipe-stem. The frequent or continual contact of certain irritating substances may induce the growth of a tumour, as soot cancer in the scrotum of sweeps.

3. An injury may lead to the occurrence of a tumour. Two cases in my own experience may be taken as examples: A young lady leaning out of the window was struck in the back by the fall of a heavy sash, and very quickly after the accident a sarcoma, which was rapidly fatal, formed at the point where she was struck. An old lady was looking on at a tennis match, when she was struck sharply on the breast by the ball, and where the blow fell there formed a large and quickly growing carcinoma.

4. There are also certain predisposing causes, particularly of malignant tumours. Of these, some are actually tumour formations: thus, a simple warty growth may become an epithelioma. Others are inflammatory; chronic inflammatory conditions of the surface of the tongue (leucoma) may lead to epithelioma.

5. In addition to these local predisposing conditions, there are several very important general conditions which may predispose to tumours. Age and sex are the most important of these. Fatty tumours are far less common in children than in adults; true carcinoma very seldom occurs in persons under thirty years of age. The female sexual organs are very liable to malignant tumours; but in parts of equal

importance in the two sexes, such as the œsophagus, lip, and tongue, men are much more liable to malignant disease than women. Anxiety and sorrow are thought to predispose to the occurrence of malignant growths. Residence in valleys is said to be much more productive of cancer than residence on hills and mountains.

6. Lastly, tumours may be congenital, as nævi usually are. And perhaps they may be inherited, or the predisposition to them may be inherited.

Growth.—The rapidity of growth, the course which a tumour will pursue, and many of its physical characters, depend partly on its structure, partly on its seat of origin. Generally speaking, the less developed the structure, the more malignant is the tumour. But tumours of similar structure differ widely in their powers of mischief, according to the part of the body in which they originate.

Tumours, like the natural tissues, are liable to accident, disease, and death. Their structure and situation, as might be expected, exercise great influence on their liability in these respects. Very large tumours, situated on the surface of the body, whatever be their structure, are exposed to injury and are liable to ulcerate and slough. Large fatty and soft fibrous growths, when they are pendulous, are peculiarly prone to ulcerate. Epitheliomata, partly because they grow on or close beneath the surface of the skin and membranes, partly because the masses of epithelium of which they are composed are ill supplied with blood, almost invariably ulcerate at an early period of their existence. In them, the ulceration sometimes extends so quickly and so deeply that the new growth is destroyed nearly as rapidly as it forms, and the essential structure of the disease can only with difficulty be discovered with the microscope. Unfortunately, tumours are rarely so completely destroyed by sloughing and ulceration that they are cured.

Again, tumours may undergo great change in their physical characters owing to degeneration and organisation. Thus, sarcomas may become organised into bone and fibrous tissue; fibrous tumours may calcify; cartilaginous tumours may soften. These changes do not usually affect the nature of the growth, which still remains essentially sarcomatous, or fibrous, or cartilaginous, as the case may be.

It is important to bear in mind these diseases and metamorphoses of tumours, for they may lead to grave errors in diagnosis and prognosis. A carcinoma of the breast may become inflamed and suppurate; a round-celled sarcoma may present the consistence of cartilage or bone; the error of mistaking the former for a chronic abscess, the latter for a cartilaginous or bony growth, can only be avoided by close attention to the history of the case and the sum of the symptoms which are present.

Classification. — Tumours were at one time classified as *innocent* and *malignant*, and the terms are still, and probably always will be, used. An *innocent tumour* has usually a structure similar to that of the tissue in which it grows. It grows slowly, thrusts the surrounding tissues out of its way; is generally encapsuled when it lies in the midst of other tissues, does not recur if it has been completely removed, does not affect the neighbouring lymphatic glands, does not occur in distant parts of the body. A *malignant tumour* is usually composed of tissues which differ more or less widely from those in the midst of which it grows. It grows quickly and infiltrates the surrounding tissues, no matter how much they differ from it in structure; it is often not encapsuled; it frequently affects the neighbouring lymphatic glands and occurs in distant organs.

Speaking generally, the sarcomas and carcinomas represent all the malignant tumours; but the endotheliomas, some of the myxomas and lymphomas, are also malignant. Although innocent tumours are, comparatively, diseases of small moment, and malignant tumours are almost invariably fatal, yet an innocent tumour may kill the individual by reason of its situation, and a malignant tumour may exist for twenty or thirty years without causing death. Thus, a simple bony tumour, pressing on the brain, may destroy the patient; a rodent ulcer (which is a definite carcinoma) may progress so slowly that it may be borne for more than a quarter of a century. Yet it is undoubtedly malignant, and exhibits its malignancy by infiltrating and destroying every tissue with which it comes in contact.

The diagnosis between an innocent tumour and a malignant tumour, of the highest importance to the patient, depends on many of the following circumstances: the history of the case, the age of the patient, the sex, the situation of the growth, the rapidity of its progress, its physical signs and the presence or absence of other tumours. The history of very long duration, and of slow growth, is in favour of innocency. Youth is almost incompatible with the existence of a carcinoma, but children suffer not uncommonly from sarcoma. Men are much more liable to malignant disease of the lip, tongue, œsophagus than women, and women are peculiarly liable to malignant disease of the generative organs. The circumstance that a woman more than forty years of age suffers from a rather quickly-growing tumour of the breast or uterus, is presumptive of malignant disease. Malignant tumours are as a rule less movable, less clearly-defined, less separable from the surrounding structures than innocent tumours. They are very prone to become adherent to the skin when growing in the breast and similar organs. And the affection of the neighbouring lymphatic glands or the presence of tumours similar to the growth which first appeared, and following it after an interval of a few weeks or months, is a strong circumstance in favour of malignancy.

It has been stated in the definition that tumours have no tendency to undergo resolution or spontaneous cure, and that they are little or not at all affected by medicine. Indeed, the only growths which appear to yield, even temporarily, to internal remedies, are some of the malignant or semimalignant diseases of lymphatic glands (lymphadenoma), which sometimes disappear under the influence of increasing doses of liquor arsenicalis. The only effectual treatment is removal or destruction of the tumour. It may be laid down as a general rule that this should be undertaken if the growth produces much inconvenience, deformity, disturbance of health, danger to life, or if it threatens to produce either or all of these conditions if it is not dealt with. The best method of dealing with each particular growth will be mentioned in the account of each.

The following classification of tumours will be adopted :

A. CYSTS.

B. SOLID TUMOURS.

1. Fatty : lipoma.
2. Fibrous : fibroma.
3. Cartilaginous : chondroma.
4. Osseous : osteoma.
5. Mucous : myxoma.
6. Lymphatic : lymphoma.
7. Muscular : myoma.
8. Nervous : neuroma.
9. Vascular : angeioma and lymphangeioma.

B. Solid Tumours (*continued*).

10. Embryonic: sarcoma.
    - „ round-celled.
    - „ spindle-celled
    - „ mixed-celled.
    - „ giant-celled.
11. Endothelioma.
12. Warty: papilloma
13. Glandular: adenoma.
14. Carcinoma.
    - „ spheroidal-celled, or glandular-celled (hard and soft).
    - „ squamous-celled (epithelioma).
    - „ cylindrical-celled or columnar-celled.
    - „ colloid.

Cysts.—A cyst may be defined as a closed sac with liquid or semisolid contents. Cysts may be divided into: 1. Those formed by the distension of previously existing tubes or sacs or cavities. 2. Those of new formation. 3. Those of uncertain origin.

1. An excellent example of the first variety is found in the ordinary sebaceous cyst, which may be due to the stoppage of the duct, and may occur on any part of the body in which sebaceous glands naturally exist. *Sebaceous cysts* frequently form on the scalp, about the face and neck, and neighbouring parts. Their contents are semisolid, and consist of a pultaceous material of offensive odour. They project, often to a large size, beneath the skin, are smooth and rounded on the surface, soft and pulpy to the feel, and the skin over the larger of them is sometimes traversed by enlarged and varicose vessels. The summit of the cyst is adherent to the skin, and a tiny depression, marked by a black speck, can often be distinguished in the adherent skin where the occluded duct opened. The cyst, if it is injured or irritated, may inflame and suppurate. *The diagnosis* of a sebaceous cyst depends partly on its

situation immediately beneath the skin, on its adherence to the skin, its rounded form and softness, on the vessels ramifying on its surfaee. Inflammation may mask the characters, and eause it to be mistaken for an abscess, but the error is unimportant. A cyst whieh is not inflamed may sometimes be cured by opening up the oeeluded duct with a fine probe, enlarging the opening with larger probes, and squeezing out the contents. The sae gradually shrivels. If the duct cannot be diseovered, or if the tumour be large, it should be dissected out. This may be done without opening the sac. But in most instances the better method is to transfix the tumour, turn out the eontents, and seizing the interior of the sac at its deepest part with a pair of toothed forceps, to draw it out through the ineision. Great care should be exereised in removing sebaeeous tumours of the scalp and back, even if they are of small size. If the patient is not in good health, or is imprudent after the operation, there is danger of cellulitis. Cysts which are inflamed should not be removed during the course of the inflammation. If they suppurate, they should be opened like a simple abseess, for the suppuration often effects a eure of the disease.

Other examples of cysts of the first variety are mueous cysts of the lips and milk cysts of the breast.

2. Cysts of the second variety may be formed by the organisation of the products of inflammation round a blood clot or foreign body. The eysts produced by parasites (hydatid cysts, etc.) are of the same variety. So are some of the adventitious bursæ, an account of which will be found in another part of this work. (*See* Art. v., vol. ii.)

3. The cysts of uneertain origin include many of the eongenital cysts. Some of these are of eourse due to errors of development, but the exact method

in which they are formed is not always apparent. Among these cysts must be classed the *dermoid cysts*, the most frequent seat of which is beneath the outer cornu of the eyebrow. There they are found in infants, appearing as a prominent, smooth, oval, soft tumour, well defined and movable, not adherent to the integument. They present many of the characters of an ordinary sebaceous cyst, without the black speck and adherence of the skin over them. If the little tumour be dissected out through an incision running parallel with the eyebrow, it will be found that the cyst-wall, so thin that it is difficult to dissect it out unbroken, contains a material precisely similar in appearance to sebaceous matter, but having fine hairs embedded in it. Large cysts of the same nature, but containing many and more complex integumental structures, or even teeth, bone, and other fœtal structures, occur under the tongue, deep down in the neck, in the ovary, testicle, and scrotum, and other parts of the body. There are no certain signs by which they can be diagnosed in most of these situations, unless by their doughy consistence. Usually, indeed, the diagnosis is not made until after the tumour is opened or removed. Some of them suppurate, are opened under the impression that they are ordinary abscesses, and are then discovered to be dermoid cysts.

Lipoma (fatty tumour).—A tumour composed of fat, differing in no essential respect from the natural fat of the body. It forms a soft lobed tumour, circumscribed, flattened, so far adherent to the skin (when it is seated in the subcutaneous tissue) that the skin dimples when it is lifted off the tumour. It is seated most frequently on the trunk and shoulders, but may occur beneath the skin of any part of the body, even of the scalp or palm of the hand. It usually forms a single tumour, grows in adults, and progresses very slowly. But cases of persons with multiple fatty growths are not rare, and children and young people are not exempt from fatty tumours.

Although the great majority of lipomata present the characters which have been described, there are several *common variations.* For example, the growth may contain a much larger proportion of fibrous tissue than usual, and may thus be much firmer than the majority of fatty growths. It may lie deeply seated between the tissues, in the intermuscular planes, or may even grow from the surface of a bone. The superficial growth, instead of presenting a flattened mass, may stand out prominent as a pedicled tumour. It is then liable to ulcerate and slough.

A frequent variety is that in which there is not a distinct and separate tumour, but a mere outgrowth of the fat, usually of the subcutaneous tissue. Such outgrowths are frequent in the neck and about the trunk. In the former situation they produce very unsightly masses, giving the appearance of great double chins and swollen necks.

A fatty tumour may, in the course of years, attain a very enormous size; but examples of the huge masses which were not uncommon before the use of chloroform in surgery are now very rarely seen. The tumour is seldom painful or tender; but this cannot be said of all cases, for some of the most typical examples of what are termed "subcutaneous painful tumours" are composed of fat. When subjected to irritation and pressure, the tumour may ulcerate or slough, and this is more liable to occur in pedicled tumours. Still more rarely pus or serum forms in the interior of the mass.

The *diagnosis* is usually very easy. The softness, almost amounting to fluctuation, the dimpling of the skin over those tumours that are subcutaneous, the situation of the tumour, its slow growth, and its manifest lobulation. serve to distinguish it from a cyst, a chronic abscess, or a bursa. The diffused continuous outgrowths are also easy to recognise, for they are uniformly soft and of slow growth. The deeper-seated tumours are more difficult to diagnose, yet even they are seldom mistaken for any but soft fibrous or mucous tumours, an error of small consequence, for the same treatment is proper for all these tumours.

It is seldom wise to attempt the *removal* of the diffused outgrowths, especially when they are seated about the chin and neck. It is very difficult to remove them entirely, and the disfigurement produced by the growths is not greater than that of the scars of the operations. They appear, too, to yield in some cases to the influence of liquor potassæ, given in doses of about ten minims, three times a day during long periods. Multiple fatty growths do not often require removal, but if one of them becomes painful, or grows quickly, it may be excised. For all single fatty growths which are growing, or are troublesome in any way, excision is the only treatment. A free incision is made over the middle of the tumour, and through this the mass, with its lobes, is drawn or dissected out. It is well not to leave any of the growth behind, for although such pieces rarely increase in size or form the starting point of a new tumour, they occasionally do so, and instances are on record in which a fatty tumour has, from such a cause, recurred several times.

Fibroma (fibrous tumour).—Pure fibrous tumours are not so common as those which are composed of fibrous tissue mingled with adipose, glandular, mucous, and other tissues. Those which occur in the breast and uterus, for example, are very seldom composed only of fibrous tissue. Even the fibrous tissue which they contain varies much in different tumours, and in different parts of the same tumour, and may resemble any of the many forms in which fibrous tissue occurs naturally in the body. Owing to this and to the close or loose texture of the mass, fibrous tumours present to the naked eye many different types, appearing sometimes uniform, pale, white; sometimes made up of shining bundles running in all directions; sometimes concentrically arranged round one or many centres.

Fibrous tumours may occur in almost any part of the body in which fibrous tissue is found; but the *commonest seats* are the breast, the uterus, the testis, the periosteum of many bones, the jaws, the sheaths of nerves and tendons, the subcutaneous tissue, the scrotum, the labium, and the intermuscular spaces. Those which grow in the scrotum and from the vulva are more often continuous outgrowths than separate tumours.

The typical *shape* of fibrous tumours is the oval or rounded shape, but they are liable to be modified by the resistance of the tissues which surround them; and most of them are nodular or bossed. Some of them, growing from the skin or subcutaneous tissue, are pendulous. Fibrous tumours may attain a large size, and this is more often the case with the softer varieties, which are very loose-textured and contain a great deal of liquid in their meshes. Such growths were formerly termed fibro-cellular, but are now included in the class of fibrous tumours, of which they form the soft variety. The best examples of fibro-cellular growths may be found growing from the labia, the skin (as pendulous tumours), and in the interior of the nose as polypi.

The large majority of fibromata are very firm, some of them actually hard. They are tolerably equal in consistence, unless they contain cysts or have softened by degeneration of parts of their substance. They grow slowly, in some instances so slowly that the bulk of the tumour at the end of ten years is not greater than that of a walnut. They are generally painless, and not particularly tender; but this rule is liable to a remarkable exception, inasmuch as some of the "painful subcutaneous tumours" are formed almost wholly of fibrous tissue.

Although usually *single*, fibromata may attack the same patient in large numbers, particularly in the nerves, the skin, and uterus. They are more common in adults than in children, but may occur at any age. They are liable to soften by mucous degeneration, and to calcify; but such changes are rare. The prominent, and particularly the pendulous, tumours may ulcerate and slough.

The *diagnosis* of a fibrous tumour is not always easy. The features to which attention should be directed are the regular shape; the uniform consistence; the nodular or bossed surface; the slow growth, and the freedom of the surrounding textures. Those in the breast and subcutaneous tissue are usually very freely movable, and are not adherent to the skin and other structures. In these situations they cannot always be distinguished from hard sarcomata, especially in the earlier stages, for the sarcomata are often encapsuled, and some of them are so far organised as to consist almost wholly of fibrous tissue. Those fibrous tumours which grow in connection with the jaws and other bones are equally difficult to distinguish from sarcomata, and reliance must be placed chiefly on the slowness of growth, the healthy condition of the covering tissues, and the regular contour of the growth. Cartilaginous and bony tumours, which may also be mistaken for fibromata, are usually much harder and more nodular.

The *treatment* proper for fibromata is complete removal. This may be performed with the knife; or, if it is desired to prevent hæmorrhage, with the écraseur or galvano-cautery. Many tumours can be enucleated in their capsules; *e.g.* those in the breast, in the interior of the jaws, and some of those which grow in connection with the sheaths of nerves. Others are dissected out with great difficulty. *Recurrence* is in any case a rare event, although sarcomas, which have become organised in great part into fibrous tissue, and yet recur as though they were still composed of spindle cells, give the appearance of a tendency to recur to some fibromata.

Chondroma (cartilaginous tumour).—Cartilaginous tumours occur usually in connection with the bones, growing within or upon the phalanges of the fingers, the humerus, the femur, the tibia and fibula of long bones, and on or in the jaws, the upper more frequently than the lower. They occur also in the salivary glands, particularly the parotid; in the testicle, and in the subcutaneous tissue. Growths of cartilage are found in and around the joints in rheumatoid arthritis, and cartilage occurs in combination with other tissues, or, as a result of organisation, in mixed tumours. Sarcomas are very liable to become in part, sometimes in large part, cartilaginous, and this has led to a belief that chondromas are not infrequently malignant.

Pure cartilaginous tumours are generally *slow-growing*, irregular in shape, sometimes rounded, almost always bossed or tuberous or nodular. They are usually very hard, but differ from bony tumours in their great elasticity. Some of them are composed of much softer material, and are compressible, but still very elastic.

They are circumscribed and covered (where they are not attached to bone) by a layer of fibrous tissue, which serves as perichondrium. When they are subjected to friction, a bursal sac forms over them. On section, instead of appearing as a single mass, they more often appear as if made up of a cluster of growths, each of which is enclosed in a capsule, and the capsules unite the separate tumours into one solid growth. The appearance of the cut section is usually that of ordinary hyaline cartilage, with the characteristic pearly hue; but it is common to find also portions which look like fibro-cartilage. Some of the separate masses which compose the growth are diffluent in the centre, some are calcified or ossified. Ossification is so common in those tumours which grow near the ends of long bones, that all that part of them which lies next, and is connected with, the bone becomes ossified, while only a thin layer of cartilage caps them. On this account they are generally classed among the cancellous osseous growths (exostoses).

Cartilaginous tumours are generally *single*, but they may be multiple and even symmetrical. Multiple chondromata of the hand are always of doubtful character, for they are not uncommonly chondrifying sarcomas, and are therefore malignant. Cartilaginous tumours may occur at any age, but they are more frequently observed in young persons; and this is true particularly of tumours in connection with the bones. This is only what might be expected, for they grow at or near the junction of the epiphysis with the diaphysis, and are, therefore, much more likely to originate during the period of activity of the mother tissue. They appear sometimes to be derived by inheritance, and are situated in the same parts in the parent and the offspring.

Although their *rate of growth* is usually very slow, they may attain a large size; but very large size, especially when associated with much more rapid growth than usual, should raise the suspicion that they are malignant. The softening of a cartilaginous tumour, and consequent formation of a liquid resembling synovia, may produce cavities like cysts, and alter the characters of the tumours almost beyond recognition.

The *diagnosis* of a cartilaginous tumour is generally easy. Its hardness, and yet elasticity; the nodules or tumours on its surface; its slow, but continuous, growth; the presence of soft parts, indicating cystic degeneration; the situation of the tumour; these are the characters on which dependence may be placed. From chondrifying sarcomas, for which they are most likely to be mistaken, they may generally be distinguished by their much slower growth, more equal consistence, and sharper contour.

Removal is the *treatment* for all cartilaginous tumours which are growing, or are painful or otherwise inconvenient. Those which grow in the testicle require, almost always, the complete removal of the organ; and some of those which grow in the interior of the phalanges necessitate amputation of the finger. But most of those which grow in the parotid and in the soft parts can be enucleated in their capsules, without disturbing the surrounding parts. The tumours which grow on the surface of the bones may be cut off with small probability of their recurrence; and even the tumours which grow in the interior of bones and distend them (those of the phalanges, for example) may often be scooped out with comparatively little damage to the finger.

The *prognosis* of pure cartilaginous tumours is good. They are not liable to recur after careful removal; and even when small fragments of them have been unavoidably left behind, they may remain quiescent, or perhaps shrivel and disappear. The cases in which recurrence has been noted, with other symptoms of malignancy, are cases of malignant tumours which have become in large part cartilaginous.

Osteoma (osseous tumour).—As is the case with the chondromata, so with the osseous tumours, the true bone tumours are liable to be confounded with tumours in which bone occurs largely in consequence of ossification of the elements of the growth. This is especially frequent in sarcomas, particularly in those sarcomas which grow in connection with the bones. But none of these are included in the description of osseous tumours proper; nor are the osseous outgrowths around the diseased joints in rheumatoid arthritis.

Of true bony tumours there are *two chief varieties:* the cancellous and the compact. Both of these are composed of true bone, the former resembling the medullary tissue, the latter the compact tissue of natural bones. The cancellous tumours have been already mentioned in the account of the chondromata, to which many of them may be said to belong more truly than to the osteomata. They grow at or near the ends of long bones, the tibia, femur, humerus, etc., where they form exostoses, which are often pedunculated. A favourite situation is the dorsal aspect of the ungual phalanx of the great toe, from which the tumour projects beneath and pushes up the nail.

The compact osteomata occur almost invariably in connection with the bones of the skull and face. The hardest of them, which are composed of layers of bone lamellæ laid concentrically over a central point or pedicle, have been named ivory exostoses. They are so hard that they can with difficulty be cut or even broken, and differ structurally from other bony tumours in the absence of Haversian canals. They grow on the flat bones of the skull, while the ordinary compact osteomata are found in the sinuses and cavities of the face and head, where they slowly grow, filling up the spaces, thrusting aside the adjacent structures, or causing absorption of them by pressure, and producing horrible deformity. The ivory tumours rarely attain the size of a small walnut, but the compact tumours may grow to a considerable size in the course of years.

Although in many instances osseous tumours are single, it is by no means unusual to meet with patients suffering from multiple osteomata, in some instances numbering more than fifty or one hundred. The growths are, in such cases, frequently symmetrical and hereditary, and are first noticed at a very early age.

The *diagnosis* of an osseous tumour usually presents no difficulty. The seat of the tumour; its extreme hardness; its pedunculated shape when forming an exostosis, and its irregular nodulated or tuberous surface when forming a large continuous mass; its slow growth; all these indicate as clearly as possible its nature. The ossifying sarcomata, with which it is most likely to be mistaken on account of the large quantity of bone which some of them contain, are recognised by their much more rapid growth and unequal consistence. (*See* also Art. II., vol. ii.)

Treatment.—The only certain method of ridding a patient of an osseous tumour is to remove it. But it is neither necessary nor advisable to remove every osseous tumour which comes under observation. The cases in which operation is desirable are those in which the tumour is painful, or steadily increasing, or very inconvenient, or the source of great deformity, and in which it is possible to remove it without greatly endangering the life or health of the patient. Thus, many of the exostoses of the flat and long bones, and some of the tumours of the upper or lower jaw, should be removed. But other tumours of the bones of the face and head, ill-defined, diffused, and extending upwards as far as the base of the skull, or perhaps actually into the cranial cavity, should not be interfered with. Nor is it advisable to remove exostoses of the long bones which are attached by very broad bases, and are deeply seated beneath a mass of muscle. The suppuration which follows is often very abundant, and the pus is apt to track up and down the limb, producing great disturbance, and sometimes serious or fatal effects.

The *prognosis* of osseous tumours, after removal, is good, provided the tumour is not an ossifying sarcoma. Even when a part of the base of attachment is left there is little fear of recurrence. There is, however, an exception to this general rule: that of the cancellous exostosis which occurs on the dorsal aspect of the last phalanx of the great toe. Although it never attains a large size, it is very obstinate, and very prone to recur when it has been even freely cut off the bone. On this account it is advisable to remove the distal portion of the phalanx, which may be done without endangering the phalangeal joint.

Myxoma (mucous tumour).—There can be no question that many of the tumours included under this head ought to be referred to the head of sarcoma, fibroma, and chondroma, for they are merely degenerated or altered examples of one or other of these growths. It is, however, possible that, after having weeded out all the doubtful cases, there would still remain a certain number of tumours which it would be needful to class under a separate heading. The softening of cartilaginous tumours has already been referred to, and the soft variety of fibrous tumour, termed "fibro-cellular," has been described. A typical myxoma contains less fibrous tissue than the fibro cellular tumour, and presents to the naked eye a jelly-like appearance. The jelly of which it consists contains mucin. The tumour is enclosed in a fibrous capsule, and the material is so loosely held together within the capsule that, when cut into, it usually oozes slowly away. Examined microscopically, the jelly is found to contain large numbers of very delicate spindle and stellate cells, with long tapering processes which freely anastomose with one another.

Mucous tumours *occur* usually in the subcutaneous and submucous tissues, in connection with the sheaths of nerves, and in the mammary gland. They grow for the most part rather slowly, and may attain a large size, although this is not often the case. They present the same characters as fatty and fibro-cellular tumours, are soft and elastic to the feel, and may fluctuate. They cannot be distinguished certainly from fatty and fibro-cellular tumours before removal; but the error of diagnosis is not important, for those of them which are not combined with sarcomatous structures are almost always innocent. This is especially true of the myxomata which grow in the intermuscular spaces, in the submucous and subcutaneous tissues; but those which grow in the breast and in connection with the nerves are far more uncertain in their course.

The *treatment* suitable for all these tumours is removal. Usually the growth shells out in its capsule, but the greatest care should be exercised in removing the mucous tumours which grow about large nerves. The nerve may pass through the centre of the tumour, which must be carefully dissected away from it. I have more than once seen a large piece of an important nerve cut completely out in the removal of such a tumour.

Lymphoma (lymphatic glandular tumour).—A disease very difficult to define, and, consequently, very difficult to describe with accuracy. The difficulty arises from the fact that the general and microscopical characters of innocent and malignant diseases of lymphatic glands may differ very slightly from each other; that the structure of diseased glands is often indistinguishable from that of normal glands; and that the structure of inflammatory hypertrophies of glands may be precisely similar to that of a lymphatic glandular tumour. It might be thought that it would be easier to distinguish these different diseases by the difference in their clinical characters; but this is not the case. In advanced conditions of disease, indeed, it may be easy to recognise respectively inflammatory and tumour diseases, but in the early stages it is often quite impossible, and it is just as impossible to recognise strumous affections from tumours. Under these circumstances it is not to be wondered that confusion prevails; nor at present does there appear to be a reasonable hope that the subject will be made more clear.

The term *simple lymphoma* may be applied in such cases as the following: A single lymphatic gland enlarges without definite cause; steadily increases in size without signs of inflammation; does not become adherent to the skin or to the surrounding structures; and has much the same consistence as a normal gland. On section, after removal, it presents much the same appearance as a normal gland, but is usually lighter coloured; it contains no caseous material, no pus. The disease is not usually limited to a single gland, but attacks two or more glands lying in close proximity. The affected glands do not attain a large size, for, after growth has slowly proceeded for weeks or months, it generally ceases, and the tumours remain stationary. This disease is unquestionably rare, for some of the cases presenting these symptoms are cases of chronic inflammatory enlargement, due to a primary exciting cause which has been overlooked or ceased to exist; others are cases of tuberculous enlargement, in which the tubercles have remained for months or years quiescent, not even becoming caseous or exciting suppuration. I have myself removed group of three or four glands which were said to have been very slowly increasing, with periods of rest, during several years, without any sign of inflammation, and have found them rich in tubercle. Yet, to the naked eye, they presented no signs of tubercle, and there was no caseation or suppuration. In doubtful cases of this kind, and almost all cases of the kind are doubtful, it is well to administer tonics and cod-liver oil, but if an effect is not speedily apparent, to remove the tumours. Whether they are simple tumours, inflammatory hypertrophies, or tuberculous, removal is the most satisfactory method of dealing with them.

Commencing much in the same manner as the last disease, and presenting for awhile precisely similar symptoms, is the singular affection to which the name *lymphadenoma* or Hodgkin's disease has been given, and which has been also named malignant lymphoma. It appears to be essentially, in many cases, a sarcomatous disease; in other instances, a general affection of the blood, or lymphatic system, and will only be referred to here, because an account of it will be found in the article on Diseases of Lymphatics (Art. XXVIII., vol. i.). The disease commences in one or more lymphatic glands, usually those of one side of the neck, grows much more quickly than the simple lymphoma, attacks gland after gland, is not limited to the region in which it first appeared, spreads beyond the glands into the surrounding tissues, shows no tendency to suppurate, produces tumours of very considerable size, affects distant organs (the liver and the spleen), and is frequently associated with an alteration of the blood, in which the white corpuscles are much more numerous than in health. It is distinguished by the rapidity of the growth of the tumours, the large size which they attain, the absence of the signs of inflammation and suppuration, and the gradual coalescence of the separate glands.

In the *diagnosis* of all these affections of lymphatic glands, the chief points to be considered are the presence or absence of the signs of inflammation, rapidity of growth, associated signs of strumous disease, and the general condition of the patient at the period of outbreak of the disease, for persons suffering from lymphadenoma are often very healthy in appearance when the disease commences. The family history will, of course, form an important part of the case; but even with every aid and every possible care, errors of diagnosis will frequently occur in the early stages of these different affections.

The *prognosis* depends so much on the diagnosis that it is impossible to lay down fixed rules for it. It may be said generally that the rapid enlargement of many glands and their coalescence into a single mass, without sign of suppuration, is a bad sign, more particularly if the glands are affected in more than one part of the body. The prognosis is not bad, so far as life is concerned, when only a small group of glands is affected, when the growth is slow, and when the tumours are separate and hard.

It has already been recommended to remove separate and firm or hard tumours which have existed a long time, and are either increasing or have become stationary, but are not diminishing in size. Even if they are tuberculous or simple inflammatory hypertrophies, removal is the best method of dealing with them. Before they have reached this stationary condition, it is probable that internal remedies against struma have been employed, and the full benefit which can be expected from cod-liver oil, iron, and various tonics, with perhaps change of air, has been exhausted. The operation for the removal of glands seated even deeply in the neck, provided they are not matted together, is, as a rule, neither very difficult nor dangerous if the dissection is carried close to the individual tumours, and if they are shelled rather than dissected out. The wounds, too, heal with surprising rapidity, leaving linear scars.

The large masses of lymphadenoma may also be removed, but the operation cannot be recommended. It is very difficult, especially when the disease has existed a long period, for the glands are not only adherent to each other, but are often so firmly fixed to the surrounding structures that they cannot be separated without serious derangement of them, or even the wounding of large vessels and nerves. In such cases, removal is followed by a speedy reappearance of the disease; indeed, it is probable that the operation will rarely be successful in taking away the gross disease, to say nothing of the tiny fragments, each of which is sufficient to form the nucleus of a new tumour.

In many cases of lymphadenoma *arsenic* has a very powerful effect. It should be administered in the form of the liquor three times a day after meals, commencing with a dose of five to eight minims. The dose is increased by one minim every week until symptoms of slight arsenical poisoning are produced, which in most persons will be when thirteen to fifteen minims are taken three times a day. Before this condition has been reached, it is probable some improvement will have been noticed if the medicine is effectual against the disease, and when the full dose is taken the glands rapidly subside. The dose may now be diminished in the same manner as it was increased. Unfortunately, the improvement is not usually permanent; in the course of a few months, in some cases earlier, the growth again proceeds, and the disease runs its course uninfluenced by any remedies. Some surgeons recommend, with the internal administration of arsenic and other remedies, the injection into the tumours of liquor arsenicalis or tincture of iodine, or of the perchloride of iron. But I have seen this practice followed by extensive sloughing and death of the patient, and I cannot recall a single instance in which it has been productive of good.

It is customary in the early stages of glandular disease, especially of disease of the glands of the neck, to paint the tumours with some preparation of iodine. The custom is one to which I have a strong objection. Although I have no doubt of its value in some cases of acute inflammation of lymphatic glands, I have never seen any benefit derived from it in chronic disease; and it certainly may cause great discomfort. The only useful local treatment is to remove with the utmost care every condition of the adjacent parts which can possibly act as a cause of further excitement in the affected glands, and to protect them from injury.

Myoma (muscular tumour).—The only tumours which appear to contain striped muscular fibres of new growth are congenital tumours; and, even in these, the muscle element forms usually an inconsiderable proportion of the mass.

Tumours composed in large part of smooth muscle fibres occur frequently in the uterus, when they are described as fibrous or fibroid tumours, in the prostate, and more rarely in the bladder, œsophagus, stomach, and intestines. In the prostate they usually produce a general enlargement of the entire organ, but in the uterus and other parts they often form distinct and definite tumours, many of which assume the polypoid shape. They are almost always so situated that they are not, at their onset, apparent to sight or even to touch, and the symptoms which they produce are discussed in the articles which treat of the diseases of the organs they affect. It is certain that they usually grow slowly and are quite innocent, although they may give rise to grave inconvenience or danger by reason of their seat. They may attain a very large size, but this is not common. The very large fibroid tumours of the uterus, which sometimes form huge masses in the abdomen, are more often due to the presence of a number of separate tumours than to a single growth. They are very firm, sometimes quite smooth, more frequently nodular or tuberose. When open, they look like fibrous tumours, and are in truth almost always composed in part of fibrous tissue. Those in the prostate contain glandular structures. They may be removed if they are so situated that they can be reached, but most of those of the uterus and prostate are treated by palliative measures, while those of the bladder and alimentary canal are often not diagnosed during life.

Angeioma (vascular or erectile tumour).—It suffices here to state that the term angeioma includes all tumours which are composed chiefly or almost exclusively of blood-vessels, whether they are arteries, veins, or capillaries, and whether the blood is contained in true vessels or cavernous spaces. It does not, on the other hand, include tumours, however vascular they may be, of which the essential element is sarcomatous or carcinomatous or fibrous or other tissue. For an account of the angeiomata, the reader is referred to the article on Diseases of Blood-vessels.

In the same manner, the **lymphangeiomata** are discussed in the article which deals with Injuries and Diseases of Lymphatics.

Neuroma (nerve tumour).—Tumours consisting of nerve fibres, whether medullated or non-medullated, are extremely rare. Nearly all the so-called neuromata are fibromata occurring in the course of nerves. An account of these tumours and of the true neuromata, as well as of the bulbs which develop about the ends of nerves which have been divided, will be found in the article on Injuries and Diseases of Nerves.

Sarcoma (embryonic connective-tissue tumour).—A tumour of connective tissue origin, formed chiefly of embryonic elements, either round, spindle-shaped, or giant cells, embedded in a more or less abundant matrix. The vessels run between the cells, and are often mere fissures or spaces.

Varieties.—The sarcomata are so numerous and occur under so many different aspects that a fourfold division of them is necessary.

The *round-celled sarcomata* are composed of cells resembling leucocytes, embedded in a homogeneous or granular basis substance, usually without any obvious arrangement. The mass is often held together by a small quantity of fibrous tissue or a meshwork. They are very vascular and grow rapidly, sometimes forming tumours of vast size, or becoming rapidly disseminated in different tissues of the body. They may occur wherever connective tissue exists, and are found commonly in the skin and subcutaneous tissue, the bones and periosteum, the lymphatic glands, the testicle, the eye, the antrum, the liver, kidneys, ovaries, uterus, lungs, and brain. Several varieties of round-celled sarcoma are recognised: the lympho-sarcoma, which resembles in structure a lymphatic gland, and occurs in the glands, tonsil, and other parts; the glioma, which has a very similar structure, but usually smaller cells, and grows from the connective tissue of nerve centres, developing especially in the brain and in the retina; the psammoma or nest-celled sarcoma; the alveolar sarcoma, which resembles in structure the carcinomata; the melanotic sarcoma, so called on account of the quantity of pigment it contains, and its consequent dark colour. The last two of these varieties may be spindle-celled instead of round-celled tumours. The melanotic tumour, whether round or spindle-celled, is found as a primary growth chiefly in connection with the skin and the pigmented tunics of the eye.

The second division is formed by tumours composed of *spindle cells.* The cells vary very much in size and shape, from tiny oats to elongated bodies, with extremely long and delicately tapering extremities. The cells are often arranged in the form of trabeculæ, so that an appearance of fibrous bands is produced, and the tumour may be mistaken for a fibrous or muscular growth. Spindle-celled sarcomata are found in connection with the skin and subcutaneous tissue; growing from the fasciæ and intermuscular septa; in the interior of bones and beneath the periosteum; in the breast, the testicle, the antrum, and the eye. It is not necessary to particularise the varieties of spindle-celled sarcomata. The melanotic have been already mentioned; the other varieties are determined chiefly by the size of the cells and the effect of organisation on tumours.

With the exception of the spindle-celled tumours, which have a trabecular structure, it is not usually possible to distinguish spindle from round-celled tumours with the naked eye.

The third division, the *mixed-celled sarcomata*, occur more often in connection with the bones than elsewhere. They are such tumours as cannot anatomically be included in either of the two preceding divisions, and are composed of round and spindle cells in various proportions, or of cells of many different shapes and sizes. They, too, bear the same naked-eye characters as the two preceding kinds, and are subject to similar organisations and degenerations.

Of these changes it is necessary to speak more fully, for they often affect a very large part of a sarcomatous tumour, and so transform it that it may be mistaken for a growth of an entirely different kind.

Thus, the embryonic tissues may be changed in great part into cartilage and bone and fibrous tissue, and the change may be so universal that only a small part of the original tissue may remain. If this part escapes observation, and all the course and surroundings of the tumour are not carefully considered, it may be mistaken for a simple cartilaginous, bony, or fibrous growth, and the mistake will lead to an entirely erroneous prognosis. The cartilaginous transformations are most common in sarcomas of the testicle; the bony in those of the bones; the fibrous in those of the subcutaneous tissue, the fasciæ and intermuscular planes. It is essential to bear them in mind in practice, and not to be too ready to accept as sheep these wolves in their assumed clothing. For, however largely the transformations have proceeded, there is no reason to hope that they will affect the course of a sarcoma or will prevent it from exhibiting all the malignant characters of the less organised growths. These transformations of sarcomatous tumours have, unfortunately, led to a very confusing nomenclature, and to the use of such terms as osteo-sarcoma, osteoid sarcoma, etc. Where they are very extensive and pronounced, they may be fairly recognised by using the terms chondrifying, ossifying, and fibrifying, but even these terms are not necessary, and the other names are odious.

The fourth division of sarcoma is the *myeloid or giant-celled*, which is formed partly of round, spindle, or mixed cells, but chiefly of large flattened cells or masses of protoplasm, containing from two or three to twenty, thirty, or even fifty nuclei. They are found in the interior of bones, usually in the cancellous ends, and affect the lower jaw, the lower end of the femur, and the head of the tibia in preference to all other bones. They can usually be easily recognised by their peculiar colour and appearance, which resemble closely those of the muscular substance of the heart.

Course.—All sarcomata are *malignant*, but the manner in which their malignancy is displayed depends partly on the structure of the individual sarcoma and on its origin. In order to give an idea of their clinical characters and of the course which they pursue, it may be well to take as examples sarcomas arising in two or three different parts of the body.

A spindle-celled sarcoma of the breast most frequently attacks women about or after the middle period of life. At first it is almost always encapsuled and freely movable, and is hard and nodular. But the age of the patient makes it suspicious, and it soon grows more rapidly than a fibrous tumour. As it increases in size, it may present a different consistence in different parts. If, as is not unusual, cysts are developed, fluctuating bosses appear. There is no affection of the axillary glands. The tumour, at first separable from the mammary gland, after a while ceases to be so, but rather on account of its size and the thrusting of the gland to one side than because the gland is invaded by it. The skin does not usually become adherent, and even when growths, forming in the interior of the cysts, at length protrude and fungate through the skin, the latter may still be separate from the fungous mass and freely movable around it. Nor is the tumour adherent to the subjacent tissues. If it remains without operation, it may become adherent at all points and may destroy life by infiltration, by sloughing, or by the formation of secondary tumours in the lungs, the liver, and other internal organs.

A giant-celled sarcoma of the lower jaw forms in the body of the jaw, slowly expands the bone, and produces a smooth swelling both on its outer and its inner aspect. The growth is so slow that several years may elapse before a tumour larger than a walnut is formed. The swelling is not adherent to the surrounding structures; is rarely ulcerated; is not associated with enlargement of the lymphatic glands. The patient is almost invariably an adult, and more often over than under forty years of age. The cavity in which the tumour lies may be opened by removal of its wall, which is thin and perhaps crackles when pressure is made upon it.

A glioma forms in the interior of the eye of a child. The sight of the eye is gradually lost. The growth of the tumour is not usually rapid and does not necessarily cause much pain. If no operation is performed, it fills the eye-ball, usually spreads along the optic nerve, not producing in the orbit a large tumour, and enters the cranial cavity, where it enlarges to a mass of considerable size. There are not usually secondary growths, and death is due to the intracranial pressure. If the eye is removed while yet the tumour is of recent formation, the patient may remain free from disease; but it is not uncommon for a similar tumour to form in the other eye, and later an intracranial tumour. Or the disease may recur in the stump of the excised ball, and thus extend to the brain.

Thus it will be seen how difficult it is to cover all the possible conditions of a sarcoma by any general account of its symptoms and course, and how very difficult the diagnosis must be in many cases. Both sexes and all ages are liable to the disease, and even children suffer from sarcoma of the eye, the bones, the testicle, the lymphatic glands, and more rarely of other parts. Sarcoma is, indeed, the malignant disease of childhood, for children are scarcely ever the subjects of carcinoma.

Most sarcomata *grow rapidly*, but this is by no means invariably the case; for although the growth of secondary tumours is rapid, some of the primary tumours increase in size but slowly. The rapidity of growth and the size attained are influenced largely by the origin of the tumour. Some of the sarcomata of the bones attain an enormous size, while those of the eye and brain are usually small. The shape of the tumour also depends very much on the part in which it grows, and is affected by the resistance of the adjacent structures. Although the tumours are, in the first instance at least, separable from the surrounding structures, they cease to be so as they advance in size; and even those which are encapsuled are not nearly so movable as innocent tumours. With regard to *the capsules* of sarcomatous tumours, though it may be said that those tumours which develop in the subcutaneous tissue, in the intermuscular planes, and in connection with the fasciæ are almost invariably provided with capsules, this is not the case with those which grow from the surface of the bones; and those which arise in the interior of organs, those of the testicle, the tonsil, the lymphatic glands, etc., speedily occupy the whole of the organ and are only encapsuled by its tunic. From what has been already said, it will easily be understood that the consistence of sarcomatous tumours may vary within the widest limits, from a softness scarcely if at all distinguishable from that of liquid to the hardness of cartilage and bone. Some of the softest sarcomata are found in the testicle and lymphatic glands, while examples of the hardest forms occur in connection with the bones. The important point to recollect in relation to *consistence* is, that the same tumour usually varies in consistence at different parts of its surface, and even hard growths beneath the periosteum are not of equal hardness everywhere. Again, the physical characters of a sarcoma may be greatly modified by the presence of cysts, and these are frequently found in sarcomas of the breast, the testicle, and bones. Sarcomata are much more liable to ulcerate than innocent tumours; and the ulceration, especially of recurrent tumours, is characteristic. It is not due to mere giving way of the integument before advancing pressure, but is preceded in most instances by infiltration of the skin, which is so changed as to form a part of the growth. An exception to this general rule may occur, particularly in the breast, where a cyst wall and the skin covering it may give way before the advancing pressure of an intracystic growth, which afterwards protrudes through a circular opening, the edges of which are thin and undermined. Whether the skin is infiltrated or whether it gives way to pressure, it becomes reddened, hot, and tender, and thus presents the signs of inflammation so as to complicate the diagnosis in doubtful cases. A sarcoma, when cut open, may appear to be cartilaginous or bony or fibrous, but, mingled with these tissues, and particularly in the outlying portions, the essential structure of the tumour can almost always be discerned. This is in most instances a succulent grey or brownish-grey material, juicy, and semitranslucent. Many sarcomata are wholly made of such material, but others are composed of a material resembling the substance of the brain or precisely similar to that of a myxoma.

Some sarcomata (those of the subcutaneous tissue and some of those of the breast) *recur* again and again after removal, perhaps ten or fifteen times in the course of many years, yet never affect the lymphatic glands or distant parts of the body; other sarcomata, on the other hand, attack the lymphatic glands within a few weeks or months of the appearance of the primary tumour. This is particularly the case with primary growths of the tonsil, the testicle, and the lymphatic glands themselves. Other sarcomata, again (the subperiosteal tumours of the bones, perhaps, above all others), are disseminated in the bones, the skin, and subcutaneous tissue, and the internal organs, but only exceptionally affect the lymphatic glands. The one feature of malignancy which all sarcomata possess in common, is that of infiltration of the surrounding tissues, so that even those which are encapsuled affect the tissues lying external to their capsules. The instances which have been given in illustration of the course of the sarcomata show how marvellously they vary in the rapidity with which they spread and become disseminated.

The **diagnosis** of sarcoma is often very difficult, and can only be made by careful attention to the peculiar features which the disease assumes in the tissue or organ under examination. Thus, a sarcoma of the breast can be distinguished from an innocent tumour by the age at which it occurs, the greater rapidity with which it grows, the formation of cysts in it; and from a carcinoma by its greater mobility, the freedom of the skin, the absence of retraction of the nipple, the presence of cysts, and the absence of affection of the lymphatic glands. A subperiosteal sarcoma of a long bone may be distinguished from an innocent tumour by the absence of a clearly defined outline, by its unequal consistence, its rapid progress, the pain and heat which are associated with the largest and quickly growing tumours. But these very characters which serve so well in the diagnosis between an innocent and a malignant growth, render it extremely difficult to decide between a sarcoma and an inflammatory affection. Here the unequal consistence of the sarcoma, its uneven surface, its continuous growth (as proved by measurements at frequent intervals), and its greater proneness to attack the ends than the shaft of a bone, are the features which must be relied on. In the most obscure cases, the diagnosis can only be made by an exploratory incision. The diagnosis of a sarcoma of the testicle cannot be made certainly from a carcinoma unless the tumour contains cartilage, or occurs in a child, when it is invariably a sarcoma. In the early stages of the disease it is often mistaken for an inflammatory affection, or a strumous or syphilitic testis. The diagnosis depends on the steady increase of size of the tumour, its varying consistence, the fact that it is the body of the organ which is affected, and the absence of the history and other signs of struma and syphilis. Space will not permit me to give a sketch of the characters by which a sarcoma may most readily be distinguished in every tissue and organ; but, speaking generally, it may be said that reliance must be placed on the unequal consistence of the tumour, the rapidity or continuity of its growth, the affection of surrounding tissues, the age of the patient, and the circumstance that the affected part of the body is one which is liable to the occurrence of such tumours.

The **prognosis** is never good, so far as the cure of the disease is concerned, but it varies very largely with the part of the body which is the seat of disease. Thus, a sarcoma of the tonsil and of the lymphatic glands is a rapidly fatal disease; a giant-celled sarcoma of the lower jaw is frequently curable by operation. A subperiosteal sarcoma of the femur almost invariably proves fatal in the course of a few months, while a central recurring sarcoma of the subcutaneous tissue of the leg may be removed many times in succession in the course of several years, or be completely cured by amputation. A sarcoma of the testicle is as malignant as a carcinoma, and only a small percentage of either disease is cured by operation.

The **treatment**, like the diagnosis and prognosis, depends largely on the seat of the disease, but it is also influenced by the structure of the tumour. The least malignant sarcomata, and probably none is less malignant than a giant-celled sarcoma of the lower jaw, may be scooped out of the cavity which contains it, and if the cavity be carefully scraped, the disease may not recur. But in all cases, and even in most cases of giant-celled sarcoma, it is far safer to remove, not only the tumour, but as wide an area of the surrounding structures as can be safely taken away. Sarcomatous tumours of the long bones should be treated by amputation of the limb high above the disease, and the same treatment should be adopted for sarcomata (not of the bones) which have been removed and have recurred, especially if they are round-celled tumours. Sarcomata of the breast are best treated by amputation of the entire breast, not by dissection of the tumour out of the breast. For sarcoma of the antrum removal of the upper jaw is practised, and even then the prognosis is not good. Sarcoma of the tonsil and primary sarcoma of the lymphatic glands had better not be treated by removal, for the results of the operation are very discouraging. Nevertheless, a sarcoma of the tonsil may sometimes be removed with the écraseur or the galvano-cautery loop to afford the patient temporary relief in swallowing and breathing. Sarcomata of the subcutaneous tissue, of the fasciæ, and intermuscular planes, must be removed by dissection when they are seated in the trunk or very high up in the limbs; and, when the disease recurs, the operation must be repeated as often as it is possible to repeat it, and the patient is willing to undergo the operation. Other general rules than these cannot be laid down. The method of removal and the instrument must be decided by the surgeon in each individual instance, according to his inclination and the probable advantages of one or the other means.

Palliative treatment is the same as for carcinoma, and will be discussed in the section on Carcinoma.

Endothelioma (endothelial cancer).—Although very little can at present be said with regard to the diagnosis and treatment of this disease, it would not be right to pass it over without notice. It is by no means improbable that many sarcomata, and some, at least, of the carcinomata, are in reality derived from endothelial elements, and are therefore endotheliomata. But the proof of this proposition is wanting, and for the present it is well to include in this class only those tumours which distinctly arise from endothelial surfaces.

The recorded cases are not yet numerous, but the number of them is every year increasing. They occur chiefly in connection with the serous membranes, growing from the inner surface of the pleura and the peritoneum. They may appear as a single growth, but more often are multiple, and many of the growths are papillary. They are generally soft, and look like quickly-growing cancers. Their microscopic structure may resemble that of epithelioma, or the typical alveolar carcinoma, so that they cannot certainly be distinguished by microscopical examination. Such tumours are naturally fatal from their situation, but, more than this, they appear to be decidedly malignant. Besides forming numerous tumours on the surface of the affected membrane, they are quickly generalised, and, before the primary disease kills by inducing effusion or repeated attacks of inflammation, many tissues and organs may be the seat of secondary tumours.

At present nothing can be said regarding the *diagnosis* of endothelioma. It is not easy to diagnose the presence of primary tumours of the pleura, the peritoneum, and other serous membranes, and there are no means by which these tumours can be distinguished from other primary tumours of the same membranes. Nor can anything be suggested for treatment.

Papilloma (warty tumour). — The simplest forms of papilloma are found upon the tongue and on the skin, where they consist of one or more hypertrophied papillæ. Their structure is that of a normal single or compound papilla, a central vessel or vessels, surrounded by a connective tissue layer, and covered by one or several layers of epithelial cells.

Warts are found frequently on the hands, especially of domestic servants; on the face and many parts of the surface of the body; on the scrotum and penis of men; on the vulva of women, and about the anus as condylomata; on the tongue of both sexes; and on the vocal cords, as well as other parts of the interior of the throat and mouth.

They usually grow slowly, and seldom attain even a moderate size; but occasionally large masses of condylomata are observed, and considerable growths of compound papillary tumours are found within the larynx, when the small size of the part in which they grow is taken into consideration. None of these tumours is dangerous in itself, but danger may be associated with a papilloma of the larynx on account of its situation at the glottis. And a danger of quite a different kind is associated with warty growths in old people, especially with warty growths upon the tongue and lower lip, for they may become epitheliomatous. The change from an innocent warty tumour to an epithelioma is generally marked by the ulceration of the tumour and by the formation of induration about its base.

Papillary growths are in many instances distinctly due to *some form of irritation;* those on the hands to dust and dirt, those on the scrotum to the effect of soot and tar, those on the penis and vulva to the action of irritating discharges.

The *diagnosis* is quite easy, for the warty character is almost always very marked, and warty carcinomata and sarcomata can usually be distinguished by their far greater activity, the presence of induration about their bases, their tendency to ulceration, and the much larger size which some of them attain.

The *prognosis* is good, although the frequency with which the warts of some parts become cancerous has led to their being always regarded with suspicion.

Treatment.—Simple warts on the hands, the face, the tongue, may be destroyed by the application to them of sulphuric or nitric acid. If the dilute acid is not successful, the strong acid must be used. The acid is carefully applied, so that it touches only the wart, which shrivels and falls off in the course of a few days. The application is usually painless. Or they may be nipped off with scissors, and the base be touched with lunar caustic. The warty growths on the larynx may be removed with forceps, or with the galvano-cautery: their treatment is an important part of laryngeal surgery. Large warts and warty growths on the integument and tongue are best removed with the knife or scissors. And, if there is any doubt whether the growth is tending to become epitheliomatous, the removal should include a part of the subjacent integument; every part, in fact, which is, even in the least degree, indurated.

Adenoma (glandular tumour).—*Varieties.* There are two types of glandular tumour, one resembling the acinous glands in structure, the other the tubular glands. The former are composed of sacs and small ducts lined with spheroidal or glandular epithelium, and are represented by the glandular tumours of the mamma: the latter are composed of tubes lined with cylindrical or columnar epithelium, and the best examples of them are found in the polypi of the rectum. But pure adenomata of either type, that is, tumours composed wholly of gland sacs or tubes with only so much connective tissue as suffices to hold together the glandular structures of a natural gland, are very rare.

Site.—They are occasionally found in the female breast, the lower lip, in connection with the salivary glands and the glands of the integument and mucous membranes. On the other hand, it is not at all uncommon to meet with tumours composed of fibrous, mucous, fatty, and other tissues, in which a greater or less quantity of glandular structure is contained. Such tumours occur very frequently in the breast, more commonly, indeed, than in any other part of the body, and comprise the greater number of the chronic mammary tumours. The glandular element is an essential part of their structure, and they are therefore rightly termed adeno-fibromata, or adeno-myxomata, etc., according to the structure of the prevailing tissue.

Course.—Their characters and the course which they pursue depend, however, much more on the structure of the prevailing tissue than on the presence of the glandular structures, so that they are, to all intents, clinically, fibrous, mucous, or mixed connective tissue or sarcomatous tumours, and not adenomatous tumours. The pure adenomatous tumours form at present so small a class that it is not easy to describe accurately their clinical characters. They appear, however, to resemble in all essential points the fibrous and other innocent tumours with which they occur so frequently in combination. In the breast they grow slowly, rarely form large masses, often not larger than a walnut or bantam's egg; are thoroughly defined, nodular upon the surface; freely movable and separable from the mammary gland; very firm or even hard; not adherent to the skin or muscle, and not producing any retraction of the nipple or enlargement of the axillary glands. They occasionally contain cysts, which are due to dilatation of the glandular sacs or ducts. They may be removed without danger, and are not liable to recur, although the appearance of recurrence may be produced in some cases by the transformation of another lobule of the gland into a similar tumour, or two tumours of the same kind may co-exist in the breast.

In the rectum they usually assume the polypoid form, occur not infrequently in the bowel of children and young persons, and may easily be detached. They are not prone to recur.

The proper *treatment* for adenomatous tumours, wherever they occur, is to remove them, and this can be done in most cases without difficulty.

A good deal of confusion has been introduced into the description of the adenomata by the fact that many different growths have been included under the term adenoma. Thus, not only the mixed tumours to which reference has been made are described as pure glandular tumours, but the French pathologists employ the term to include certain tumours which have lost the typical glandular structure and have become actual carcinomata. The term "adenoid," which is applied to some of these growths in Great Britain, is far less objectionable, although I should much prefer that all such growths were named "carcinomata," in accordance with their actual disposition and characters.

Carcinoma is defined as a tumour of epithelial origin, generally presenting an alveolar structure. The cells resemble usually those of the epithelium from which they are derived. They are not embedded in a matrix, like the cells of sarcoma, but lie closely packed within alveoli, formed by fibrous tissue: they multiply generally by endogenous formation. The vessels traverse the fibrous tissue, and rarely lie between the cells.

Varieties.—Four great varieties of carcinoma may be made, but it is certain that many specimens of the fourth, if not indeed all of them, are merely altered examples of the first variety. They are the spheroidal-celled (which includes the hard and soft carcinomas); the squamous-celled (epithelioma); the cylindrical-celled, and the colloid.

Spheroidal-celled or glandular-celled carcinoma is derived from the epithelium of acinous glands and those of the tubular glands which are lined with glandular epithelium. It includes the tumours commonly recognised as hard and soft carcinoma, between which the essential difference appears to lie in the greater quantity of fibrous tissue which the hard contain, and the overwhelming preponderance of cells in the soft carcinoma. The hardest examples of the hard form are usually called scirrhus: indeed, the term scirrhus is often applied to the whole group of hard cancers.

Hard spheroidal-celled carcinoma is found primarily in the breast and alimentary canal, where it grows most frequently about the pylorus. A few examples have been met with in connection with the glands of the integument. A full account of the disease will be found in the article on Diseases of the Breast, but the general characters must not be passed by here. The tumour forms an indurated, irregular, nodular or tuberous mass; continuous with the gland, but at first freely movable with the gland; growing usually quickly, yet not generally forming a large mass. As it increases in size, it affects the surrounding structures, infiltrating or drawing them into itself, and thus becoming adherent to the skin, the muscles, fasciæ, and other parts. This property of carcinoma produces some of the most characteristic symptoms of the disease, and is responsible for many of the difficulties in removing it. If the tumour reaches the integument, it may change it into a hard, dull red or livid material, and in time ulcerate. The ulcer forms an irregular chasm, with everted edges, which are very hard and commonly tuberous; the surface of the ulcer is also tuberous or nodular, often partly covered with slough, and seldom or never with granulations. If the primary growth is seated in the breast or the œsophagus, the lymphatic glands become enlarged; but if it is seated at the pylorus, they often escape the disease. The case may terminate within a few months by secondary formations of carcinoma in the liver, the lungs, the bones, and other parts; and the skin is very liable to be the seat of numerous nodules. But in the large majority of instances the patients live for as many as twenty-four or more months, and may even exist for as many as ten or twenty years, most of which are passed in enduring a foul ulcer, which bleeds from time to time. Ulcerated carcinomata are generally believed to be less prone to produce secondary affection than carcinomata which are not ulcerated.

The hardest varieties of hard carcinoma (the scirrhous tumours) present this peculiarity, that they tend to draw towards themselves the surrounding structures, extending their long processes from the small shrivelled lump which forms the tumour, and dragging the tissues towards the lump which nevertheless does not grow larger, but on the contrary rather shrinks. In this manner it sometimes happens that an organ like the breast, which has been the seat of cancer for many years, is actually considerably reduced in size, and there remains nothing more than a kind of cicatrix, bound down to the ribs so firmly as to form one with them. Unfortunately, the tumour is not cured, however much it shrivels; secondary growths may arise in distant parts of the body, and the patient may perish from disseminated carcinoma. Some of the worst forms of hard carcinoma are those in which there is no definite tumour when the affected part is cut open after removal or death, and in which there is no shrinking such as takes place in the scirrhous tumours, but the disease is disseminated through the healthy tissues in cords and nodules.

The appearance of a hard carcinoma, when cut into, is usually that of a very firm opaque white mass, of the consistence of a turnip. The cut surface is juicy, often blotched or streaked with blood, in many cases traversed by fibrous bands; creaking when cut, and presenting a concave section. The tumour may be circumscribed and clearly defined, but is scarcely ever encapsuled. It is not separable from the tissues in the midst of which it lies, and frequently islets of fat and other normal tissues can be discovered in the outer portions of the new growth, which has extended between and around them, but has not yet completely transformed or destroyed them.

Soft spheroidal-celled carcinoma, which is also known by the names of medullary and encephaloid, is not so common a disease as hard carcinoma. It occurs primarily in the breast (but rarely), the testicle, the bladder, liver, kidneys, the ovaries and the interior of the eye. In its typical form it has a brain-like appearance and consistence, which fully justifies the name encephaloid which was at one time so frequently applied to it. In its clinical characters it differs from hard carcinoma chiefly in the fact that it grows much more quickly, and runs its course in much less time; it forms usually a larger mass; it is, as its name implies, a soft tumour, and may be so soft that it fluctuates like an abscess. The course and general characters of a soft carcinoma of the testicles are so similar to those of a sarcoma of the same organ that the description of the latter would pass for that of the former. The only differences, clinically, are that the carcinoma never contains bone or cartilage, and that carcinoma never occurs in children.

For all practical purposes, it must be borne in mind that there is no essential difference between a hard and soft carcinoma, and that the two varieties run one into the other. In the secondary affections, the one variety is sometimes replaced by the other, and the distinction is so artificial that a tumour which one surgeon will term soft, another equally experienced will call hard.

Speaking generally of all spheroidal-celled carcinoma, it may be said that the disease is *rare before the age of thirty*, but from that age until the end of life it is not uncommon. Again, it is much more common in persons after than before forty; and it is not improbable, if the proportion of aged persons to the total number of living persons in the community were taken into account, that it might be found to increase in frequency during each decennial period of life. Females are much more liable to it than males, chiefly on account of the extreme liability of the female breast to cancer.

The *growth* of soft carcinomata is rapid, while that of the hard carcinomata is usually rather slow, unless it is compared with the rate of growth of innocent tumours, such as the fatty, the fibrous, and the bony tumours. Neither the soft nor the hard carcinomata usually form very large growths, such tumours, for instance, as the huge sarcomatous tumours of the bones; but occasionally a very large tumour is formed in the breast or testicle, and the liver is sometimes enormously enlarged by infiltrating cancer. The secondary growths often greatly exceed in size the primary disease, and attain a huge size in a far shorter space of time. The shape of a spheroidal-celled carcinoma varies very much with the variety of the disease and the organ in which it occurs. Those of the testicle are usually large ovoid masses, with low bosses, separated by shallow grooves. Those of the breast which are soft form large globular or tuberous masses. The diffused tumours of the liver, which are generally primary, sometimes maintain very singularly the natural shape of the organ. On the other hand, the hard, shrivelled scirrhous cancers of the breast produce only very little tumours, and sometimes no tumour at all, but only a shrivelling and induration of the affected parts. And some of the hard carcinomata of hollow organs, such as the stomach and the bladder, produce a general and very uniform thickening and induration of the walls of the organ, which is often associated with considerable diminution in the size of the cavity, and of course with an absolute incapacity to expand or contract.

Among the *changes* which spheroidal-celled carcinomata undergo, perhaps none is more important, from a clinical aspect, than the softening, which may be due to fatty degeneration or to other pathological occurrences. The carcinomata which soften when they reach the skin, before they break form large fluctuating masses, and are not infrequently mistaken for abscesses. The diagnosis is made by attention to the history of the case, and by observing that the consistence of the tumour varies in different parts, and particularly that the base is hard, or at least distinctly solid, while the superficial parts are soft and fluctuating. Another result of softening is the formation of cystoid cavities in the interior of carcinomatous tumours, cavities often of considerable size, so that the tumour gains the character of a true cystic tumour. In addition to cystoid cavities, true cysts form in the carcinomata of the breast, the testicle, and other glandular organs.

The **manner of extension** of a carcinoma is by infiltration of the adjacent structures, and this produces an important clinical feature, for it accounts for the adhesions of the tumour and the less and less mobility, until in the latest stages it becomes absolutely fixed.

Secondary affection of the **lymphatic glands** is produced by most carcinomata, or it would perhaps be more correct to say, by the carcinomata of most parts. Those of the breast, the testicle, the bladder, affect the lymphatic glands; those of the antrum and the eye very seldom, and as it were only by chance.

Dissemination is common in connection with the carcinomata of almost every part; and the organs liable to be affected are the skin, the bones, especially the vertebræ, the liver, lungs, kidneys, brain, and other internal organs. The possibility of secondary affection ought always to be kept in mind, even when a primary carcinoma has shrivelled up and become apparently quiescent, and when there is no sign of recurrence *in situ* after removal of a primary growth. In such patients pains in the lower extremities, with other obscure symptoms of spinal mischief, should always raise the suspicion of cancerous affection of the spine; and pains in such a bone as the femur, associated with swelling as if from ostitis or periostitis, of secondary carcinoma of the bone. If there is cancer of the bone a spontaneous fracture frequently occurs; and I have more than once seen a case in which, without any previous pain or noticeable swelling, the femur has spontaneously broken by reason of secondary cancerous disease in its medullary canal. In the same manner, anomalous cerebral symptoms sometimes occur many months after the removal of a primary carcinoma, and gradually terminate in death, when the post-mortem examination reveals a secondary tumour of the brain. In some rare instances, the secondary disease affects many bones, and, without producing a distinct tumour in any of them, so changes their structure as to render them peculiarly brittle, that they break with the most trivial accident, or indeed spontaneously.

In the large majority of cases of spheroidal-celled carcinoma there is no serious difficulty in making the **diagnosis.** The age of the patient, the comparative rapidity with which the tumour has increased, its adherence to the tissue or organ in which it has arisen, and its increasing immobility, are most valuable signs. Also the characters of the ulceration when there is ulceration. But there are some cases in which I believe it is impossible to make a correct and certain diagnosis. Thus, I have seen simple cysts and chronic abscess of the breast mistaken for carcinoma, and an encapsuled carcinoma (a very rare disease) mistaken for a simple fibrous tumour; while in those parts of the body in which carcinoma and sarcoma are of almost equal frequency, such as the testicle, it is in most instances quite impossible to distinguish between the two diseases. Between chronic inflammation and carcinoma, or chronic abscess and carcinoma, the difference is usually determined by the greater hardness of the carcinoma, the absence of fluctuation, the steady enlargement, and the associated circumstances, such as pregnancy or lactation when the breast is the seat of the disease. Between cyst and carcinoma the diagnosis depends on the circumscribed form and greater mobility of the cyst, and its greater elasticity, even if there is not perceptible fluctuation. In the later stages of the disease, the condition of the overlying skin and of the neighbouring lymphatic glands is of great importance in determining the nature of the tumour.

In those cases in which there is fluctuation, and there is difficulty in deciding whether this is due to the softening of a carcinoma or to the presence of pus or cystic fluid, a puncture should be made with a fine trocar and canula, or with a grooved needle; and in all cases in which there is the least doubt of the nature of the disease, an incision should be made into the tumour before an operation for its removal is performed. Not long since a breast which had just been removed for carcinoma was sent to me for examination from the country. It was still unopened, and when I cut into it, a quantity of clear liquid escaped and the "carcinoma" disappeared. Had the incision been made before instead of after the amputation, the woman would have kept her breast and been spared the danger of the operation.

The *treatment* of the spheroidal-celled carcinomata will be considered when the other varieties of carcinoma have been described.

Squamous - celled carcinoma.—Epithelioma is composed of masses or columns of squamous epithelial cells, like those of the skin and tongue. The masses or columns dip down into the subjacent tissues, and gradually infiltrate every structure with which they come in contact. They contain globes or nests of flattened epithelial cells.

Squamous-celled carcinomata may *grow* from any part of the body which is covered by squamous epithelium, and are frequently found where skin and mucous membrane meet. Of the external parts, they occur, taking the parts from above downwards, about the head and face, upon the nose and lower lip, on various parts of the body, on the penis and scrotum in the male, the vulva in the female, at the anus in both sexes. They are rare upon the limbs, but are occasionally seen upon the hands and feet. Of internal parts they attack the tongue, palate, gums, tonsils, larynx and pharynx, the œsophagus down as far as the entrance to the stomach. They are found in the bladder of both sexes, at the orifice of the uterus in females.

Epithelioma is very unusual in persons under the *age* of thirty, and is much more usual after forty years of age. It attacks men more frequently than women. Thus epithelioma of the lower lip is a disease almost limited to men; epithelioma of the tongue, the œsophagus, and the larynx many times more frequent in men than women. In considering the causes of the disease this point will be again referred to.

Epithelioma may *commence* in the form of a wart or warty growth, a crack or fissure, a tubercle, a nodule or lump; or an ordinary ulcer may become epitheliomatous. The disease is liable to attack scars, and usually commences then as an indolent ulcer in the middle of the scar tissue. No matter what is the original form in which the disease appears, it almost invariably ulcerates at a very early date, and the ulceration often advances so rapidly in proportion to the rate of increase of the new growth that epithelioma appears rather to belong to the class of ulcers than of tumours. In some cases, however, the new growth proceeds steadily, and the ulceration is only superficial until a tumour of considerable size is formed. Such a tumour presents on section a white opaque juicy surface, from which yellowish plugs can be squeezed out. There is no capsule, but the margin of the growth is clearly defined. Its consistence is liable to considerable variation, but the tumour is always harder than the surrounding textures. This harder consistence is of great clinical importance, for the characteristic induration of the edges and base of epithelial ulcers depends upon it. A wart may ulcerate upon the lower lip, but until the characteristic sign of induration around the ulcer is observed the diagnosis of epithelioma is not made. An ulcer forms upon the border of the tongue, remains indolent and unhealed for many weeks, but is not recognised as epithelioma until its base and borders become hardened. If, now, the ulcer is removed, the induration is found to depend on the presence of a layer of the same opaque white substance which forms the larger tumours. The appearance of an epithelial ulcer may resemble that of other carcinomatous ulcers, but it is usually a more indolent sore, sometimes a mere chink or cleft, and in not a few instances it is covered with papillary projections so as to assume the appearance of a warty or cauliflower growth.

The *rapidity of growth* and the *size* attained by epitheliomata are extremely different in different parts of the body. On the lower lip the disease usually extends very slowly, and may take three or four years to reach the size of a nut. In the tongue the rate of growth is often very rapid, and a mass of considerable size may be produced in a few months. The softer and more vascular the tissues are, and the warmer and moister the affected part of the body, the more luxuriant is the growth of the disease. Like other malignant tumours, it affects every tissue with which it comes in contact; fat, fibrous tissue, bone, and even cartilage. An epithelioma commencing in the skin of the leg extends down to and into the tibia, pervades it until the bone is so altered and softened that it breaks spontaneously or with the slightest violence. An epithelioma of the gum affects the surface of the jaw; crumbles it away until at length it eats into and completely through it.

The *lymphatic glands* are affected by the epitheliomata of most parts of the body, those of the lip, tongue, tonsil, penis, scrotum, vulva, and the skin of many parts. On the other hand, epitheliomata of the antrum, of the skin of the face (many instances of rodent ulcer), of the intrinsic parts of the larynx, rarely affect the glands. The exception in the case of the intrinsic parts of the larynx is the more striking, because epitheliomata of the extrinsic parts affect the glands certainly and early.

Epithelioma may be *disseminated* in other parts of the body, but dissemination is not so frequently observed as in the case of most of the other forms of carcinoma and of the sarcomata. Secondary tumours occur in the liver, lungs, kidneys, the bones, and different parts of the skin.

Squamous-celled carcinoma may usually readily be *diagnosed*. The small size of the tumour, the early ulceration, the indolent character of the ulcer, the induration about its base, the warty surface which it not uncommonly displays, are the signs by which it is recognised. If to these are added the seat of the disease, and the age and sex of the patient, the diagnosis of most cases is singularly easy. As examples may be taken an ulcer of the lip, a lump upon the tongue, and a warty growth upon the scrotum. A fissure or crack is seated on the prolabium of the lower lip, with induration extending a quarter of an inch or more into the subjacent tissues, so that there appears to be a body like a small nut in the substance of the lip. The ulcer is indolent, discharging watery liquid, having an irregular or warty surface, often covered with scab. There is no surrounding inflammation; probably no pain. The patient is a man of fifty to seventy years of age, and the disease commenced many months previously as a wart or crack, which was perhaps cauterised or picked off, but quickly formed again, and slowly spread. In the second case, an indolent lump exists in the substance of the border of the tongue. It is much firmer than the adjacent portions of the tongue, is smooth, ill-defined, not particularly painful or tender. There is no inflammation about it. Its surface may be cracked or ulcerated. It is very likely situated opposite a ragged tooth, and may be attributed to the irritation of the tooth. The patient may be a man or woman, but is much more probably a man over five-and-thirty years of age, and the disease has existed from four to six months.

The third case is that of a chimney-sweep or worker in tar. There are several, perhaps many, warts upon his scrotum, but one of these is larger and harder than any of the others. It is also ulcerated, and a foul sore has formed, discharging offensive fluid, and having an indurated base and edges. The induration extends some distance beneath the skin. The sore is not inflamed. The man is forty to sixty years of age, and the wart has been slowly changing its character for the last five months.

There can scarcely be a doubt in cases such as these, and if the lymphatic glands are enlarged in association with the disease, the diagnosis is as clear as it can be of epithelioma. The lump in the border of the tongue may possibly be a gumma or a tuberculous mass, but in either case there will almost certainly be some associated signs of syphilis or tubercle.

In those cases in which there is an ulcer, and they form the vast majority of the total number of cases of epithelioma, great assistance in making the diagnosis may be gained by scraping the surface of the sore gently with a knife, and examining the scraping placed in a drop of water on a microscopic slide. The scrapings taken from syphilitic and tuberculous ulcers, which are by far the most liable to be mistaken for epithelioma, are composed of pus, blood, the débris of food, and micrococci and other parasitic masses. Those which come from an epithelial ulcer contain many epithelial cells, distorted, varying in size and shape, with two or more nuclei, and, not uncommonly, cell nests, or portions of cell nests. In all doubtful cases, this method of confirming the diagnosis should be employed.

Epithelioma can, more certainly than any other form of malignant disease, be clearly ascribed to some *predisposing cause* or source of irritation. Thus, warts or sore places on the lip, which are continually picked or irritated; cracks or sores on the tongue which are rubbed by a ragged tooth; the continual presence of soot in the furrows of the scrotum; chronic inflammatory conditions, and white patches on the tongue and cheeks, are all of them conditions favourable to the development of epithelioma.

An account of rodent ulcer, which is a variety of squamous-celled carcinoma, will be found in the article on Ulcers.

Cylindrical or columnar-celled carcinoma is a much rarer disease than either of the two preceding. It is often described as a variety of epithelioma, but there are many reasons against this course. It originates from cylindrical epithelium, either from that covering the surface of mucous membranes or lining glands, and in its structure resembles the parts from which it grows. There are no cell nests or epidermic globes. It is met with most frequently in the uterus and rectum, but may occur in other portions of the intestinal canal. It has also been descried in the air passages, the milk ducts, and bladder. It forms an indurated mass in the wall of the organ in which it grows, producing considerable narrowing of canals, ulcerates at an early period, but varies greatly in the rapidity with which it extends. It infiltrates the adjacent structures in the same manner as other carcinomata. The glands are affected in many instances of primary disease of the rectum and uterus, and secondary tumours, bearing the same general and microscopical characters as those of the primary disease, occur in the liver, the lungs, and other parts. For a longer account of the clinical characters of this variety of carcinoma, the reader is referred to the article on Diseases of the Rectum.

Colloid carcinoma is also called alveolar carcinoma on account of the cells, or alveoli, in which the colloid material is contained. The alveoli are sufficiently large to be discovered by the naked eye, and are sometimes of considerable size. The colloid material resembles soft jelly, and is usually so diffluent that part of it escapes when the alveoli are opened. The appearance of the disease is thus very characteristic.

It is doubtful whether colloid carcinoma is not always a degenerate or altered form of one of the preceding varieties of the disease, especially of the spheroidal-celled carcinoma, for cells resembling spheroidal epithelium are found embedded in the colloid jelly.

The disease occurs frequently in the walls of the stomach and large intestine, in the omentum, and rarely in the breast. When it occurs as an external tumour, for instance in the breast, there are usually no signs by which it can be distinguished from the ordinary carcinoma of the breast. It runs a similar course to the ordinary form of carcinoma, occurring in the parts of the body in which it grows, but is rather slower, and may therefore be considered less malignant.

Villous carcinoma may be mentioned, because the term villous is occasionally used in connection with cancer, especially with cancer of the bladder and intestine. It does not, however, imply a special variety of carcinoma, but merely that the cancers which occur in those parts of the body occasionally assume a tufted or villous form. The essential structure of the disease is the same, and the course which it pursues is not affected by the outward form of the tumour.

In the same way it is necessary to warn the student that the tumours which are sometimes named osteoid cancers are almost invariably ossifying or calcifying sarcomata. The formation of bone in true carcinomata, or even the deposition of calcareous salts, is very rare.

The radical treatment of all forms of carcinoma is their complete removal or destruction wherever this can be accomplished, and the condition of the patient justifies the operation. When an organ, such as the eye, the breast, or the testicle is the affected part, the entire organ should be removed. But when the tumour is destroyed by means of caustic, the complete destruction of the breast itself is not rigidly insisted on. In the case of the breast, however, and in every part of the body in which it is possible, a surrounding area of apparently healthy tissue ought to be removed with the tumour. Thus, in the amputation of a carcinoma of the breast, it is customary (and the custom is one which ought not on any account to be departed from) to take away a large elliptical portion of the integument, even when there is no affection of the integument, so far as can be seen. When a carcinoma is deeply seated in a limb, when, for instance, a squamous-celled carcinoma, commencing in the skin of the leg, has made its way into the tibia, amputation must be performed, and the limb should be cut off high above the disease. Glands which are affected in association with the primary disease should be removed when their complete removal can be effected. This is frequently done in the case of enlarged and carcinomatous glands in the submaxillary and parotid regions, the axilla, and the groin. Quite apart, however, from the immediate and remote dangers of such operations, the mere fact of the presence of glandular enlargement renders the prognosis of the disease, wherever it is situated, much more gloomy. It is an indication of a more advanced malignancy, and there is much less hope of a successful issue of treatment. Yet, even when the glands are extensively diseased, and there is no hope of removing them, the primary tumour may sometimes be removed with great advantage to the patient. This is particularly the case in carcinomata of the tongue and penis, when the primary carcinoma can be freely and easily removed, and is, or is likely to become, the source of great pain and grave inconvenience to the patient. The prospect of radical cure by operation, of whatever kind, depends largely on the situation and nature of the disease. Epithelioma (squamous-celled carcinoma) of the lower lip is perhaps the most amenable to treatment of any form of carcinoma. Small epitheliomata (rodent ulcers) of the face may be cut out with good hope of curing them. Eight or ten per cent. of operations for carcinoma of the tongue are successful in curing the patients, so that at least no recurrence takes place within two or three or more years, whereas the disease, if left to itself, usually proves fatal in twelve or eighteen months. Probably a greater number of cases of carcinoma of the breast are cured by operation; and many of them, if they are not cured, are decidedly relieved, the disease returning in some other part of the body, and terminating without any apparent tumour, and without the distress of an open ulcer. Carcinoma of the testicle is a very fatal disease, and carcinoma of the œsophagus and tonsil are rarely, if ever, benefited by any operation directed to the radical cure of the disease.

With regard to the manner of dealing with the disease, a great deal depends on its situation and on the age and general condition of the patient. In the vast majority of cases the knife is employed as the surest and most surgical instrument in the hands of a dexterous surgeon. But the tongue is removed more commonly with scissors or with the galvano-cautery or the écraseur ; small epitheliomata of the face may be destroyed by the application of nitric acid or the acid nitrate of mercury, or Vienna paste. And even large tumours of the breast in delicate or very elderly women may with greater safety be destroyed by the application of Vienna paste or chloride of zinc, or finely powdered asbestos mixed with three times its weight of strong sulphuric acid. By one or other of these agents, successive layers of the tumours are removed, until the entire mass is destroyed, and a large cavity is left which gradually heals up from the bottom. The defect of this method of treatment is that the amount of destruction cannot be so certainly regulated as it ought to be, and that it is tedious and infinitely more painful than removal with the knife. Yet there are many persons who will prefer the most tedious and painful treatment rather than submit to anything which is termed an operation. The manner of using asbestos and sulphuric acid is described at length in a pamphlet published by Dr. William Bell.*

I am not aware of any *internal remedy* which will cure a carcinoma, but I think I may say that I have seen patients improved by the administration of Chian turpentine. The tumour or ulcer has lessened in size, or partly healed under its influence, and the general health has improved. In no instance, however, have I seen a permanent cure effected, although I have seen several patients who have been treated by the originator of the treatment. And on the other hand, I have seen such persons whose disease has not been modified in the least degree by the administration of Chian turpentine. If Chian turpentine, or any similar

*" Michel's Process for Removing External Tumours." London. 1871.

remedy, is employed in the treatment of carcinoma, it should only be as an adjunct to other means, or in default of other means in cases in which no operation is admissible.

When a case of carcinoma is considered to be *beyond the reach of radical treatment*, and is, therefore, regarded as hopeless, there is too great a disposition to leave the patient to his fate, only giving opium when the pain of the disease is excessive. This is a very grave mistake, and one which cannot be too severely blamed. Pain may be allayed by the internal administration of morphia or opium, the doses of which must be directed to completely allay the pain, not limited by the mere pharmacopœial notion of what is a sufficient dose for an adult. The external application of menthol, either in the form of a cosmetic stick or mixed with an equal part of oil of cloves and ten parts of spirit, I have known soothe some persons suffering from external cancers which were not ulcerated. I have also used ointment of equal parts of the ointments of belladonna and aconite for the same purpose with good effect. Some of the quickly-growing acute cancers are eased by the constant application of lead and opium lotion, or of lead lotion without the opium. For ulcerated cancers, cocaine mixed with water in various proportions may be used as a spray, or carefully painted on the painful part. And in more than one such case I have used, with admirable effect, a powder composed of two grains of iodoform, and a sixth of a grain or more of morphia dusted on the painful spot.

The stench of open ulcers is often more difficult to combat than the pain. For this purpose poultices of charcoal or powders of iodoform and charcoal, or lotions of sanitas, or bichloride of mercury, or or carbolic acid may be used. Gamgee's antiseptic pads may be employed with great advantage in treating fœtor.

XXV. INJURIES OF BLOOD-VESSELS.

A. PEARCE GOULD.

A. **Injuries of arteries.**—The injuries of arteries may be considered under the heads of *contusion*, *laceration*, and *wounds*.

1. **Contusion.** — The severity of this injury varies greatly. In the slightest cases there is no gross change produced in the vessel, and no immediate effect, but the vital properties of the intima are so altered that in a few hours or a day or two the blood gradually coagulates at the injured spot and blocks it up. The only evidence of such an injury is the occlusion of the artery, coming on not at once, but at an interval after the injury. When the contusion is more severe the brittle inner and middle coats are torn across and curl up inside the adventitia. The blood then coming in contact with tissues uncovered with intima speedily coagulates upon the ends of the torn coats, and the clot extends until the blood channel is completely blocked. This condition is marked by arrest of pulsation at a particular spot in an arterial trunk, coming on immediately after an injury.

Where the contusion is more severe still, not only are the two inner coats divided and curled up, and a clot formed upon them, but the adventitia may be severed, and so crushed that its elasticity is destroyed, and it falls over the end of the plugged vessel; or, without division of the vessel, its outer coat may be so bruised that its vitality is destroyed and the dead part is separated and its place occupied by new living tissue.

Treatment.—This resolves itself into the preservation of rest for the artery, its protection from injury, and attention to the parts deprived of their direct blood supply. (*See* page 386.)

2. **Laceration** deserves a separate notice, because its effects upon the arteries are so special. When a vessel is over-stretched to the point of laceration, the brittle inner and middle coats quickly snap and curl up within, while the outer coat is drawn out, stretched beyond the play of its elasticity, so that after it snaps across its ends fall over those of the vessel. It thus happens that even the largest arteries may be torn across without the occurrence of hæmorrhage, and it is a well known fact that lacerated wounds are particularly free from bleeding. No special *treatment* of the laceration is required.

3. **Wounds.**—When an artery is completely severed its cut ends contract and retract within the cellular sheath of the vessel in a way that will be further spoken of when describing the natural arrest of hæmorrhage. When an artery is incompletely severed, and the wound is transverse to the axis of the artery, it gapes widely; when the cut is longitudinal its edges do not gape, and blood escapes only or chiefly during the ventricular systole; when the wound is oblique it is intermediate in character.

Hæmorrhage is *the* symptom of a wounded artery. A fine puncture may be inflicted upon an artery without causing any bleeding. The nature of the wound in the soft parts has a considerable influence upon the effects of a wound of an artery. Where it is a simple incision, the blood escaping from the artery is freely spurted from the wound, but when it is of the nature of a punctured wound or a valvular incision, the blood cannot thus freely escape, and it tends to infiltrate the cellular tissue of the part, along which it may spread for a great distance. If the external wound is closed while the bleeding from the artery continues, this tendency is greatly increased. In this case the injury is similar to the subcutaneous rupture of an artery. When the infiltrated blood is in small quantity and does not form a distinct tumour, it is known as an *extravasation* or *sugillation;* when it forms a distinct tumour but the communication with the artery is closed, it is an *hæmatoma;* and when the communication between the artery and the blood tumour persists it is a *traumatic aneurism.* (*See* page 450.)

When an artery is divided completely across, the parts to which it is distributed are at once deprived of blood. But, owing to the free communications between the small arterioles, blood is quickly poured into the empty vessels from neighbouring ones in which the circulation is uninterrupted. The complete division of an artery also stops the pulse in the vessel beyond and in its branches; when, however, an artery is only wounded, and not completely severed, a certain amount of pulsation may still be detected in it and in its branches beyond.

The **healing** of a wound in an artery is fully described in the section on Hæmorrhage (page 356). The complete division of an artery leads to its complete occlusion; but a small wound in a vessel, one extending not more than one quarter of its circumference, may be healed up without occluding the vessel, plastic lymph first sealing up the wound and then firmly cicatrising it.

B. **Injuries of veins.**

1. **Contusions of veins** arise under similar conditions to the contusions of other parts. When quite slight they may not give rise to any consequences which will enable them to be recognised; if more severe they lead to coagulation of the blood in the vein. (*See* page 389.) When the contusion is more severe still it leads to the death of all the coats of the vein and to the coagulation of the blood

within it; this occurs in severe crushes of parts, such as are followed by local death.

2. **Lacerations of veins** occur where limbs, or parts of limbs, are violently torn off from the body, as in the reduction of dislocations, especially when these are of old standing. Laceration may completely occlude a vein, as an artery, but owing to the smaller amount of elastic and muscular tissue in its walls, a torn vein may continue to bleed when its companion artery is completely closed. Thus it happens that very extensive and even fatal hæmorrhage may occur from a subcutaneous laceration of a vein.

3. **Wounds of veins** are of very common occurrence. They heal in the same way as a wounded artery; but obliteration of the vessel is much less frequent. Where a vein is quite severed, the channel is never restored; but a considerable wound may be made across a vein without the vessel being obstructed.

4. **Entrance of air into veins.**—This is one of the rarer accidents attending a wound of a vein; but its effects may be so disastrous, and it occurs so suddenly, without warning, that it is necessary to be well acquainted with its phenomena. Experiments on animals have shown that a small quantity of air can be injected into a vein without serious consequences; and that if the injection is made very slowly and gradually, a large quantity of air may be introduced without causing the alarming or fatal effects which follow the sudden introduction of a smaller quantity.

Causes.—During inspiration, and especially during a laboured effort to fill the lungs, the blood in the great veins converging upon the heart is sucked in, while during expiration an opposite effect is produced. This effect of respiration upon the flow of blood is only seen in the veins about the root of the neck, for beyond that the walls of the vein collapse under the influence of suction; if, however, this collapse is prevented, either by thickening of their coats or by their being held in a state of tension, or by their adhesion to unyielding structures, the aspiration of the chest may influence veins at some distance, such as the facial and subscapular. The spontaneous entrance of air into a vein only occurs when an opening is made into a vein which is affected by the aspiration of the chest. These conditions, which prevent the collapsing of a vein, have been called by the French the "canalisation" of veins; and, adopting this phrase, we may say that air enters the circulation only when the aspiration of the chest sucks it in through a wound in a canalised vein. The deeper the inspiratory effort, the greater the amount of air introduced, and hence the heavy breathing of patients under the influence of ether to some extent increases the liability to this accident.

The effects of the entrance of considerable quantities of air into the venous circulation have been studied in animals. The right auricle and ventricle, and the pulmonary artery and its branches, are found filled with frothy blood; while the left side of the heart is empty. The right ventricle is unable to force this mixture of blood and air through the lungs, the left ventricle is therefore unable to send blood to the brain, and the patient dies of syncope. When only a small quantity of air is introduced into the circulation, it gradually becomes dissolved in the blood, and possibly some of it escapes into the air vesicles of the lungs; in this way the cases of recovery are explained.

Symptoms.—These may be described as local and general. At the moment of air being sucked into a wounded vein, a peculiar sucking or hissing sound is heard, and frothy blood is then seen to issue from the vessel. The general symptoms vary much in intensity. The patient suddenly becomes pale, his pupils dilate, his pulse is flickering or imperceptible, while at the same time exaggerated respiratory efforts are made, and the heart's action is powerful and turbulent, and a peculiar churning sound is to be heard on listening over the præcordia. These alarming symptoms may gradually subside, and the patient recover; or they may terminate in death, which may or may not be preceded by convulsions. When the accident is fatal, death usually occurs in a few minutes; but if successive quantities of air are sucked in, the fatal issue may be longer delayed. In more than one recorded case death has occurred after some days from bronchitis or pneumonia.

Treatment. — The first thing to do, on hearing the peculiar sucking sound or seeing the frothy blood in the wound, is to compress the opened vessel with the finger, and in that way to prevent both further hæmorrhage and the entrance of more air into the vein. As soon as possible the vein should be accurately secured, either by forceps or a ligature, and the surgeon's hand set free. In the mildest cases this may suffice.

Treves advises that time should not be spent in looking for the wounded vein, but that the further entrance of air should be prevented by filling the wound with water. By this measure also the air in the right auricle can be, to some extent, got rid of, especially in children, by compressing the chest wall during expiration. The water in the wound will allow the air to escape, while it will prevent more from entering. Treves also points out the evil effects produced by attempting artificial respiration in these cases.

Where there is syncope and distressed respiration, the surgeon should endeavour to keep up the heart's action until the obstruction in the lungs is overcome by the gradual solution of the air or its escape into the air cells; at the same time efforts should be made to keep the brain as well supplied with blood as possible. The patient should be placed in a horizontal position, and if the heart's action grows weak it should be stimulated by hypodermic injections of ether, brandy injected into the rectum, a sinapism over the præcordia, and ammonia held to the nostrils, one or more of these means being used as they may be at hand or required. By compressing the axillary and femoral arteries, a large proportion of the blood which succeeds in passing through the lungs will be sent to the brain, and in that way fatal syncope may be warded off.

HÆMORRHAGE.

The varieties of hæmorrhage, or bleeding, are classified according to the vessels from which the blood escapes, and also according to the time after the injury at which the bleeding occurs. Thus, we speak of *arterial*, *venous*, and *capillary* hæmorrhage, and also of *primary*, *intermediary*, and *secondary* hæmorrhage. These may be called the anatomical and the clinical varieties of hæmorrhage.

Phenomena of external hæmorrhage.—Any one acquainted with the phenomena of the circulation of the blood will have no difficulty in at once distinguishing between arterial, venous, and capillary hæmorrhage. When blood is seen to flow from the whole surface of a wound, oozing out like juice from a cut orange, and not escaping from definite points which can be recognised as the mouths of severed vessels, it is usually spoken of as *capillary hæmorrhage.* The blood is generally bright red in colour, and really escapes from the arterioles of the part; the bleeding from a cut finger is a familiar instance of this variety of hæmorrhage. It is the least important variety, as the escape of blood is slower and is more easily arrested than when vessels of larger calibre are opened.

When an *artery* is wounded, bright red blood is propelled in a forcible stream, which rises with every beat of the heart, and falls in the interval; as the loss of blood continues, and the heart's power becomes less, the distance to which the blood is propelled diminishes, and the effects of the ventricular systole become less marked, until the blood merely trickles from the end of the vessel. A similar but more rapid effect is often produced by the natural arrest of hæmorrhage.

The characteristic features of arterial hæmorrhage may be lost in one of two ways. When the blood does not escape directly, but flows along a sinuous or narrow wound, it no longer escapes in jets, but flows evenly and continuously; the rapid loss of bright red blood at once reveals the source of the hæmorrhage. Where a patient is more or less asphyxiated, the blood flowing from a wounded artery is dark in colour.

When a *vein* is wounded, dark red or purple-black blood wells up in a constant stream which is uninfluenced by the cardiac contractions. From a large vein the flow is very rapid, and the blood is projected to some short distance from the wound. When the vessel is completely divided, the blood is seen to come from the distal end only; but in the case of a wounded artery, while blood always spurts from the proximal end, it often also trickles or even spurts from the distal end too, either at once, or after an interval; this is especially to be observed in the arteries of the head and face, where the anastomoses are very free.

The force and rapidity with which blood flows from a wounded vessel depend upon the size of the vessel and its nearness to the heart, the size and the direction of the wound in the vessel, and the force of the heart's contractions. The complete division of a vessel, particularly of an artery, tends to close the vessel and arrest hæmorrhage by permitting the retraction and contraction of the cut ends.

Constitutional effects of loss of blood.—When one of the largest blood-vessels, either artery or vein, is freely opened, death takes place almost instantly from syncope, being often preceded by convulsions. Where the hæmorrhage is less abundant, its effects are shown by increasing pallor of the skin and mucous membranes and increasing frequency with diminishing power of the pulse, which is gradually lost in all the arteries except those of the first magnitude. The patient experiences a sensation of nausea and "faintness," with noises in the ears, and flashes of light before the eyes, and then becomes unconscious. The breathing is hurried, and there is a great sense of want of breath. The limbs are flaccid, but the arms are often listlessly thrown about, and the skin is bathed in a profuse perspiration. From this state the patient may die, or may slowly recover. If he recovers, he is liable to pass into the state of *hæmorrhagic fever*, when reaction is established, the temperature being raised and the pulse quickened, with a full wave but an empty artery between the cardiac systoles; the patient experiences considerable thirst, owing to the great absorption of water from all the tissues. For some time after a severe loss of blood there is marked anæmia, which may continue throughout the patient's life or be slowly recovered from, the individual being meanwhile an easy prey to other diseases, both acute and chronic.

The loss of a given amount of arterial blood produces a greater effect than the same amount escaping from a vein, the difference being due to the relative oxygenation and carbonisation of the blood. Infants bear the loss of blood badly, a relatively small loss being either fatal or attended with profound syncope. After puberty, and especially in early adult life, hæmorrhage is borne well, and its effects are most quickly recovered from. With increasing age, loss of blood becomes both more serious and more permanent in its effects.

Treatment.—The first aim is to arrest the hæmorrhage. Where the immediate symptoms are severe, the patient should be laid flat on his back and kept perfectly quiet, being warmly but lightly covered, with, if necessary, hot bottles to the feet, thighs and trunk; care should also be taken to have the air breathed as pure as possible. If, in spite of the arrest of the hæmorrhage, the syncope increases and the pulse becomes weaker, stimulants should be used to avoid death from cardiac failure. A subcutaneous injection of ether (♏ xx to xxx for a dose) is the best means to adopt, the injection being repeated as required; other good means are a sinapism over the heart and an enema of an ounce of brandy in 2 to 3 ounces of hot water; the brandy should not be injected alone, as both the heat and the additional fluid supplied by the hot water are powerful adjuvants. In cases where death is threatened from extreme loss of blood, transfusion may be practised (page 360). Esmarch's bandage may be temporarily applied to one or to all of the limbs, with a view of driving all the blood into the trunk and head; the bandages should not be kept on longer than necessary; certainly not beyond six hours. A similar effect can be temporarily produced by raising the arms and legs well up above the trunk, or by compressing the axillary and femoral arteries. Stimulants should never be given unless absolutely essential to save life from increasing cardiac failure, because both the dilatation of arteries, and the increased cardiac contraction they cause, tend to displace coagula from wounded vessels and excite renewed hæmorrhage. When the more immediate effects have been recovered from, the patient is still to be kept as quiet as possible, warm, in good pure air, and to have at first only fluid diet, milk and beef tea; gradually, as strength and digestive power increase, eggs, bread, puddings, and then fish and meat, may be added. When this stage is reached, iron should be given, the reduced iron in gradually increased doses (gr. iii to xii per diem) being a very good preparation; afterwards, when convalescence is further advanced, a more astringent preparation may be found better. During convalescence every care should be taken to conserve the energy of the patient; and, whenever possible, the ordinary duties of life should not be resumed until the anæmia is recovered from. Should the symptoms of *hæmorrhagic fever* present themselves, the bowels should be emptied by an enema, and a draught containing citrate and bromide of potassium be taken three times a day. In many instances the effects of hæmorrhage are combined with those of shock.

Transfusion is a procedure that has been found very valuable in properly selected cases. The cases suitable are those where life is endangered solely from loss of blood; it is incapable of removing the ill effects of shock or of chronic visceral mischief, and therefore its sphere of usefulness is somewhat limited. Blood is the best material to inject into the vessels; and so far as present experience goes, it appears that it does not materially matter whether it is pure blood or defibrinated blood that is injected, for in acute anæmia the urgent need is for red corpuscles to absorb oxygen from the lungs and convey it to the tissues. Milk and saline solutions have also been used for transfusion; about four ounces of warm milk may be slowly injected into a vein, but equally good results are obtained from the transfusion of a suitable saline solution. The quantity of fluid injected must be regulated by the effect produced, but a few ounces is usually sufficient to remove the immediate danger to life. The fluid is most conveniently introduced into one of the veins of the elbow, and care must be taken to use fluid at a temperature of from 98° to 100° Fahr., and not to inject any air with it; the apparatus used should, therefore, be completely filled with fluid in every part before the injection is begun. If transfusion is determined upon, it should be performed without delay; and, where possible, blood from a healthy robust adult, between the ages of twenty and thirty-five, should be taken. In default of blood, the following solution is the best substitute: Chloride of sodium, 50 gr.; chloride of potassium, 3 gr.; sulphate of soda, and carbonate of soda, each 25 gr.; phosphate of soda, 2 gr.; water, 1 pint. The use of blood introduces a special danger, that of embolism from a small portion of clot being passed in to the recipient's veins, and special means have to be employed to prevent it. One plan is to draw the blood into a clean vessel standing in hot water, to whip it thoroughly, and then to strain it through a fine cloth into another similar vessel; in this way all the fibrin is removed, and the blood is maintained at a suitable temperature. The blood is then injected through a suitable syringe, previously warmed; an aspirator or a hydrocele syringe will do. This is called *mediate transfusion.* A better plan is to pass the blood direct from the arm of the donor to the recipient (*immediate transfusion*), but for it some special form of syringe is required, and the operation requires rather more dexterity for its proper performance. Aveling's apparatus is the most serviceable; it consists of a miniature Higginson's syringe without valves, and with a silver canula attached to each of the rubber tubes. Roussel's apparatus is very ingenious, and most successful in the inventor's hands, but to use it properly it requires some considerable practice with it.

1. The **natural temporary arrest of hæmorrhage** is simply and solely a process for stopping bleeding, and is, therefore, peculiar to wounded vessels, without counterpart in lesions of other tissues. The process depends upon two main factors: (*a*) *The contraction and retraction of the vessel;* (*b*) *the coagulation of the blood.* When hæmorrhage has been severe these are reinforced by (*c*) a *change in the composition of the blood, and* (*d*) *enfeeblement of the heart's action.* So that the greater the loss of blood the greater nature's power of arresting it.

(*a*) The **contraction and retraction of the vessel.**—When an artery is cut quite across, the muscular fibres of its middle coat *contract*, and narrow or even close the orifice, in this way lessening or stopping the bleeding, and drawing away the end of the vessel from its surrounding sheath. At the same time the cut ends *retract* one from the other within the sheath, owing to the normal longitudinal tension of arteries. The result of the retraction of the vessel is that the blood does not escape from the surface of the wound, but has to flow along the interior of the arterial sheath, and this both favours the formation of, and provides room for, the "external clot." The contraction is a vital process, depending upon the direct stimulation of the muscle in the vessel wall by the injury; it is capable of being artificially increased or lessened. The retraction, on the other hand, is a physical effect, and depends upon the elasticity of the vessel, and the looseness of its connection with its sheath and surrounding tissues. It cannot be artificially increased, although it is seriously interfered with in certain conditions of the tissues, such as "solid œdema," and where, as in the soft palate and tongue, the muscular tissue contracts and leaves the cut artery flush with the surface, or even projecting beyond it. These changes in the vessel wall are very powerful aids in the natural arrest of hæmorrhage; and it is important to notice that neither of them can come into play unless the vessel is completely severed, so that bleeding from a wounded artery may sometimes be instantly arrested by completing the severance of the vessel; this is the recognised treatment of hæmorrhage from a wounded artery of the frænum, or of the superficial temporal artery, and in some other scalp wounds.

(*b*) **Coagulation of the blood.**—This is the essential factor, without which the other would be of little avail. The coagulation is excited by the contact of the blood with the divided vessel wall, the inner surface of the sheath from which the vessel has retracted, and with the air. The clot at first merely narrows the channel through which the blood escapes, but as it increases it gradually blocks it up entirely, filling up the sheath beyond and around the end of the artery, and sometimes projecting on the surface of the wound; this is called the *external clot*. Coagulation soon spreads from the clot in the mouth of the vessel to the blood which is more or less stagnant in the closed end of the artery, and here it forms a clot called the *internal clot*, which extends in typical cases as far as the next branch. This clot is conical in shape, with its apex directed away from the wound, and is usually smaller than the lumen of the vessel. The three portions of the one continuous coagulum play very important parts in the natural arrest of hæmorrhage; the central portion actually prevents the flow of blood from the wounded vessel, the external clot supports it against the expellant force of the blood in the artery, and the internal portion protects it from the direct impact of the blood.

(*c*) **Alteration in the blood.**—After considerable hæmorrhage, an effort is made to compensate for the quantitative loss by an absorption of watery fluid from the soft tissues of the body. This change renders the blood more rapidly coagulable, just as the addition of a moderate quantity of water to blood outside the body increases its coagulability.

(*d*) **Enfeeblement of the heart's action** is one of the chief effects of an abundant hæmorrhage; by lessening the rapidity and force with which blood flows from a wounded vessel, it favours its coagulation and the adhesion of the coagula to the vessel and the sheath.

The arrest of hæmorrhage from a vein is almost entirely due to the coagulability of the blood, for there is little elasticity or contractility to aid in the process. On the other hand, the fact that veins collapse when cut across aids in arrest of hæmorrhage from them.

2. **The natural permanent arrest of hæmorrhage** is a process by which the wound in the vessel is securely closed by a cicatrix. This is brought about by the *exudation of plastic lymph* and its subsequent *organisation.*

The lymph first appears as a small grey button in the part of the clot adherent to the mouth of the vessel, being poured out by the vessels of the torn arterial coats. From thence a grey discoloration of the clot from its infiltration with this lymph spreads up the internal clot and through the external clot. With the effusion of this lymph the adhesion of the central part of the clot to the cut end of the vessel becomes much firmer, and the closure of the vessel more secure. During this stage the artery contracts upon the internal coagulum. The next step is for new vessels to form in the exuded lymph; these are formed as outgrowths from those in the sheath or in the coats of the vessel; quickly the organisation of the cellular lymph proceeds until it is converted into a mass of vascular fibrous tissue, which gradually shrinks into a small fibrous cord; and, in some cases, after lapse of time it is impossible to identify even this remnant of a pre-existing vessel. The clot takes no active part in the production or organisation of the lymph, and the closure of a wounded vessel is therefore to be regarded as in all points similar to the repair of other tissues, the clots, both internal and external, serving to plug the wound in the vessel until the permanent closure is effected, and as a good nidus for the organisation of the coagulable lymph.

The Surgical Arrest of Hæmorrhage.

The surgical means of arresting hæmorrhage are: *Pressure, cold, heat, styptics, actual cautery, forcipressure or crushing, acupressure, forced flexion, torsion ligature.*

Pressure is the most readily available and the most generally applicable of all hæmostatics. It is employed either as a mere temporary expedient until some other means can be adopted, or is relied upon entirely to control the bleeding. For the former purpose tourniquets are employed. Similarly, the most furious bleeding can be instantly arrested by placing the finger on the mouth of the vessel, until it can be seized in a forceps or tied.

When, however, it is used as a distinct and sole hæmostatic, its action resembles the contraction of a divided artery, for it narrows or closes the open vessels, and allows of the formation within them of a clot. It is specially applicable where blood is trickling from several small vessels. In many cases a compressing pad and bandage is employed not only as a hæmostatic, but also to keep the parts of a wound in apposition, and favour union by first intention. Pressure is used to arrest bleeding from larger arteries, when it is inconvenient or impracticable to employ other means, as in the scalp and palm. In these cases it is important to apply the pressure exactly upon the bleeding point, and for this purpose a graduated compress is generally employed. If the pressure is made with precision, it is not necessary to have it very forcible; and wherever forcible pressure is applied, it must not be continued longer than is necessary for the formation of a firm adherent internal clot (say twelve hours), or else it will cause sloughing of the bloodless tissues.

Cold acts as a hæmostatic, by exciting contraction of the muscular coat of vessels. It is, therefore, of no avail in vessels which are only partly severed, and it is more effectual in arterial than in venous hæmorrhage. It acts quickly. Sucking ice is used to arrest bleeding from the mouth and throat; iced injections will control epistaxis in many instances, and an ice bag applied to the surface will often moderate bleeding in deeper parts beneath. The mere exposure of a wound to the air will sometimes suffice to arrest bleeding that had been kept up by the natural warmth of the body.

Heat acts like cold by causing contraction of the muscular coat of divided arteries, and like cold, it acts quickly. A temperature of over 120° Fahr. is required, and water at a temperature of 130° to 160° is generally employed; at a higher temperature the tissues are injured, while a lower temperature encourages bleeding by relaxing the vessels. Under a stream of hot water, operations upon the face and other very vascular parts become almost bloodless.

Styptics arrest hæmorrhage by contracting the arteries, coagulating albumen and hastening the coagulation of fibrin. They fail to act unless brought into immediate contact with the bleeding vessel, and washing away of the styptic by the flowing blood is a frequent source of disappointment. The surgeon should, therefore, wipe the wound quite dry, and then apply his styptic as accurately as possible to the actual bleeding point, using at the same time pressure to control for a few moments the flow of blood. Strong styptics interfere with the healing of a wound by first intention. They are of service chiefly in bleeding from cavities, as the mouth, nose, and uterus, where other means are inapplicable, or in controlling bleeding from ulcerated tumours. The most frequently used styptics are alum, persulphate of iron, tannin, or gallic acid, in form of powder, the solid stick of nitrate of silver, and solutions of alum, perchloride, or persulphate of iron and turpentine. Turpentine, acetate of lead, the astringent salts of iron, and ergot, are given internally with a view of causing contraction of arteries and increased coagulability of the blood.

The **actual cautery** is a very powerful hæmostatic. It usually acts by closing in the end of the wounded vessel by a firm eschar formed of all its coats, behind which the blood quickly coagulates. Sometimes the eschar is formed of the outer coat only, and the two inner coats are curled up inside the vessel. (*See* Fig. 14, A.) The cautery should be at a black or dull red heat, and be applied accurately to the bleeding point, and held in contact with it for a few moments; failure often results from a neglect of these two precautions; a bright red or a white heat is not hæmostatic; it can easily be demonstrated outside the body that the closure of an artery by an eschar takes many seconds, the time varying with the size of the vessel. The cautery prevents the healing of a wound by primary intention.

Forci-pressure, or crushing, has superseded to a considerable extent both torsion and ligature of wounded vessels. Catch forceps are used with strong, bluntly serrated ends; these forceps usually bear the name of Kœberlé or of Spencer Wells (Fig. 11).

When applied to a divided vessel they completely crush the part grasped, and at the same time break across the brittle inner coats, which curl up within the vessel; the crushed part in the form of a flat band closes over the end of the vessel, while the blood clots within the vessel over the ends of the inner coats. Such forceps are used in

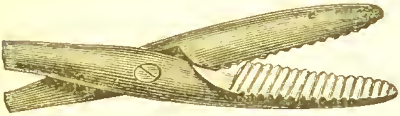

Fig. 11.—Forci-pressure Forceps.

many ways; bands of vascular tissue may be clamped by them before division; the largest vessels may be temporarily held in them until closed by a ligature or by torsion; or the bleeding points in a wound may be

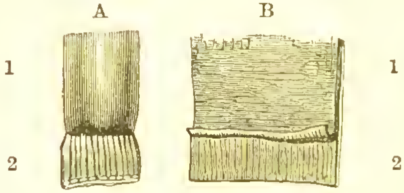

Fig. 12.—A. An Artery closed by Forci-pressure. 1, Normal artery; 2, crushed extremity. B. The same artery laid open. 1, Normal artery; 2, crushed and serrated outer coat; 3, inner coats separated and curled up.

seized one by one, and held in the forceps for a few minutes, when, on removing them, the bleeding will be found to be staunched; arteries as large as the ranine are readily sealed by these forceps, and in such an operation as the excision of the mamma it is often unnecessary to resort to any other means of controlling bleeding. Whenever possible the bleeding vessels should be seized clean in the forceps without grasping surrounding fascia or muscle, as in this way the vessel is more completely crushed and the amount of crushed tissue left in the wound is less.

Acupressure is seldom used, and rather in the form of a suture than as a simple hæmostatic. A long needle or har-clip pin is made to transfix both sides of a wound, and then a silk thread is thrown around the ends of the needle in a figure of 8. In this way the edges of the wound are held firmly in apposition, and at the same time the bleeding vessel is compressed between the pin and the silk. It may be thus used in bleeding from scalp wounds, in the operation of hare-lip, in wounds of the face, etc.

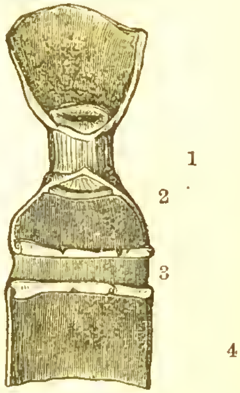

Fig. 13.—An Artery which has been crushed with Forceps in two places. 1, Compressed outer coat; 2, two inner coats, rolled up, partially occluding lumen. Below the vessel is laid open: 3, outer coat; 4, inner and middle coats.

Forced flexion is used as an adjunct to other means. It is especially useful for wounds of the hand, for when the elbow is flexed to the full degree the lumen of the brachial artery is much narrowed. The influence of forced extension of the elbow is still more marked. A similar effect can be obtained by forcible flexion of the knee.

Torsion is one of the best methods of arresting arterial hæmorrhage. When the cut end of an artery is seized in suitable forceps, drawn upon gently and then twisted round seven or eight times, its brittle inner coats quickly snap across and roll up inside, whilst its elastic outer coat curls up into a ball at its extremity; the effect upon the vessel being very similar to its laceration. The artery should be seized as cleanly as possible, and in twisting large arteries care should be taken not to introduce one blade of the forceps inside the vessel. Torsion may be trusted to close even the largest arteries. Advanced atheroma is also no bar to its use. Veins can be closed by careful torsion as well as arteries. The subsequent changes in a twisted artery are described on page 372.

The **ligature** of vessels is the most important of all hæmostatic agents.

(1) *Effects.—(a) Immediate.* The brittle inner and middle coats are divided as if cut with a knife and curl up within the vessel, and the portion of the outer coat within the noose is strangled. The smaller the thread (provided only it is strong enough to bear the required strain) the more easily are the two inner coats divided. When a severed artery is tied in a wound, all the vessel beyond the noose dies, but in the ligature of an artery in its continuity, only the ring of vessel actually encircled by the thread dies.

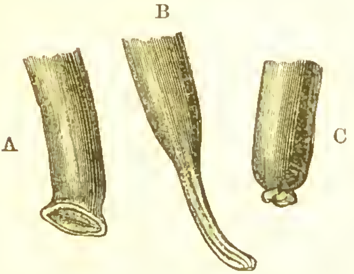

Fig. 14.—A. Artery closed by actual cautery. B. Artery closed by laceration. C. Artery closed by torsion.

(*b*) *Later.—Changes within the vessel.* Blood coagulates upon the ends of the divided inner coats; this clot gradually increases in size and length, until in about three days it fills the vessel more or less exactly as far as the lateral branch nearest to the ligature. It is conical in shape, and adheres first and most firmly to the divided vessel wall. The base of this clot in about twenty-four hours is found of a buff colour, and this change in the clot increases both in intensity and area, being caused by the exudation into it of organisable lymph. This lymph becomes vascularised, and organises into cicatricial tissue, which permanently obliterates the vessel, usually as far as the origin of the nearest branch. The internal clot may disintegrate and disappear; it also may be very limited in extent, and not reach as far as the next branch. When an artery is tied in its continuity the internal clot is usually formed later, and is shorter on the distal than the proximal side of the thread.

Changes around the vessel. — The infliction of the wound and the presence of a ligature cause an exudation of coagulable lymph within the sheath of the vessel, around the ligature, and over the end of the vessel. If the ligature is, or becomes septic, this plastic lymph breaks down into pus, and at the same time the strangled end of the vessel is separated from the living by a line of ulceration; the thread, with its enclosed slough of vessel, is then discharged. This "separation" of the ligature takes from one to three weeks to accomplish, according to the size of the artery and the precision of the ligature; when strands of fascia are included in the noose the time may be considerably prolonged; and all the while the presence of the irritating thread is a source of danger from the liability of the ulcerative or sloughing process to extend along the vessel. Usually the vessel is securely closed by the organisation of the internal clot before the ligature separates, and the ulcerated end of the vessel is closed in by cicatricial fibrous tissue. If, however, the lumen of the vessel be not thus firmly occluded, when the ligature separates the danger of *secondary hæmorrhage* is very great; and if ulceration or sloughing of the vessel wall extend beyond the

Fig. 15.—A tied Femoral Artery six days after Amputation of the Thigh; showing the artery slit open; the internal coagulum; and the ligature.

internal coagulum the same result follows. It therefore follows that in all septic wounds the presence of a ligatured artery is a source of additional danger from this tendency to secondary hæmorrhage. When the ligature is and remains aseptic, and there is no other irritation of the part, the coagulable lymph in which the ligature and the enclosed part of the vessel is embedded organises in the same way as that which infiltrates the internal clot, and the end of the vessel is firmly closed over by cicatricial tissue. The part of the vessel which has lost its vitality is slowly eroded by the corpuscles of the lymph and is absorbed, its place being occupied by lymph and finally by cicatrix. Similarly, if the ligature be absorbable, it, too, is gradually softened and eroded from the surface until it is entirely absorbed, and in its place a band of cicatricial tissue is left. If the ligature is not absorbable, it becomes encapsuled in the scar tissue. When an aseptic ligature is applied so that it does not strangle the vessel, the part in the noose is not absorbed. It an absorbable ligature is quickly softened and eroded, before the internal coagulum has formed and become organised, the vessel may be opened out again, and the constricted ring of the artery being weakened by division of the inner coats, and by the softening of traumatic arteritis, may then yield and form an aneurism.

The changes occurring in a twisted artery are so similar to those just described that they may be most conveniently mentioned here. The twisted end of the vessel is quickly embedded in coagulable lymph, and unless it is infected from the discharges of the wound it is absorbed and replaced by cicatricial fibrous tissue. Exactly similar changes occur in vessels closed by forci-pressure or the actual cautery.

Precautions to be observed with the ligature.—(1) An aseptic ligature should be used. (2) The ligature should be of such a nature that it is readily encapsuled in living tissue, or is absorbed after such an interval as allows of the previous firm occlusion of the vessel. (3) Wherever possible, the vessel only, without any of the surrounding tissue, should be tied. (4) The knot should be fastened with the least possible disturbance of the vessel; it should be tightened gently and gradually, sufficiently firmly to divide the inner coats, and tied in a reef-knot, and not a "granny" (Fig. 16). (5) When an artery is tied in its continuity a healthy part of the vessel should be selected, and a spot at some distance from a large branch.

Complications of the ligature.—(1) *Septic inflammation* or sloughing in the wound is very liable to cause secondary hæmorrhage. (2) Advanced *disease of an artery* may not only prevent the successful application of a ligature, but it may also interfere with the healing process. (3) When a vessel is tied in its continuity, if the *sheath is extensively opened*, the blood supply of the part immediately beyond the ligature will be so seriously interrupted that a sufficient effusion of lymph does not take place, and the arterial coat ulcerates, and secondary hæmorrhage ensues. (4) In vessels tied in their continuity near a large branch, the rush of blood through the branch seriously interferes with the formation of a thrombus. (5) *Enclosure of a vein* or a portion of a vein may cause thrombo-phlebitis or gangrene.

Fig. 16.—A Reef-knot.

The choice of a ligature.—(*a*) *Waxed thread.* Compressed whipcord or silk, well waxed to prevent the knot from slipping, is the old-fashioned ligature; the wax has the additional advantage of rendering it less absorbent and able to hold in its pores only a small amount of septic matter. As this kind of ligature always necessitates ulceration of the vessel, its use is now almost entirely abandoned.

(*b*) *Aseptic silk.*—Silk that has been boiled in water for some time, and then kept in a 5 per cent. watery solution of carbolic acid, is aseptic. It must not be waxed before it is used. It is not absorbed, but remains encapsuled in the scar.

(*c*) *Catgut* is the most largely used of any aseptic ligature. Carbolised catgut can be employed, but catgut hardened and rendered aseptic by chromic acid is now used in its place. If properly prepared, "chromic gut" is aseptic, and resists the absorbent action of living tissues for many days; it does not soften too soon. The gut may be either encapsuled or absorbed.

(*d*) *Ox aorta.*—Spiral strips of the middle coat of the aorta of the ox straightened by over-stretching, and rendered aseptic by immersion in a 5 per cent. solution of carbolic acid have been used by Mr. Barwell. This ligature is flat, and can be used without severing or strangling the vessel; it is absorbed by living tissues, and is replaced around a vessel by a band of cicatricial tissue.

(*e*) *Tendons.*—Long strips of tendons, especially those from the tails of kangaroos, dried, and then carbolised, are aseptic, absorbable, and strong.

(*f*) *Wire* ligatures are inconvenient to apply, and, if encapsuled, are liable to irritate the cicatrix and excite suppuration.

PRIMARY HÆMORRHAGE.

Primary hæmorrhage is that which occurs directly from the opening of a vessel. We will consider its treatment under the headings of wounds of arteries, veins, and capillaries.

Treatment of wounded arteries.—If the hæmorrhage is free, it should be instantly arrested by compression of the bleeding point or of the main artery of the part. When the bleeding point can be seen, as in an amputation, the artery should be closed by forci-pressure, torsion, or ligature. Where arterial blood is welling up from a deep flesh wound, as *e.g.* a stab in the thigh or the axilla, the main vessel should be controlled above, the wound cleaned of all coagulum, and the injured vessel sought. If the artery is divided, both ends should be closed by torsion or ligature, and if the vessel is incompletely severed, a double ligature should be placed on it, above and below the wound.

Treatment of wounded veins.—In a large number of cases the presence of valves in veins, the low pressure of the venous blood, and the simultaneous division of the corresponding artery, remove the necessity for any local treatment of a wounded vein. Any impediment to the venous circulation, such as a tight bandage or respiratory obstruction, and a pendant position of the part, increases the hæmorrhage. Where the wound is small and otherwise adapted for it, moderate pressure with a pad and bandage suffice to control the bleeding. Other wounds of veins are to be treated by torsion or ligature, of which the latter is most generally used. When a small wound is made in a large vein, such as the femoral or axillary, a ligature should be placed both above and below the wound, and the vessel divided between. Similarly, when a branch of a main vein is severed close to the trunk, a double ligature should be placed around the trunk. A lateral ligature should rarely be employed.

Treatment of capillary hæmorrhage presents no serious difficulty. Cold, or heat, or gentle pressure by pad and bandage, or strapping, or other like means, is always sufficient. In situations where these cannot be employed, styptics should be used.

INTERMEDIARY HÆMORRHAGE.

By this term is understood bleeding which occurs from some failure in the temporary arrest of the hæmorrhage. It comes on within the first twenty-four hours after a wound, before the permanent closure of the vessel is at all advanced, and is to be viewed as a recurrence of the primary hæmorrhage.

Causes.—Its causes are (1) *reaction,* which is attended with increased heart power, by which soft coagula may be forced out of vessels recently plugged, and with relaxation of the arteries tending to loosen clots. It is thus known as reactionary hæmorrhage.

The other great cause is (2) *movement* of the part, which displaces a clot over a vessel, or a badly applied ligature.

The *treatment* is but a renewal of the efforts made to control the primary hæmorrhage; the actual conditions of the vessels are the same in both cases, and intermediary hæmorrhage is but a recurrence of the primary bleeding.

SECONDARY HÆMORRHAGE.

Secondary hæmorrhage is that which is due to failure in the permanent arrest of bleeding, or the healing of a wounded vessel. Clinically it is defined as that which comes on at any time between the end of the first day after a lesion and the complete cicatrisation of a wound.

Causes.—1. Such *constitutional conditions* as pyæmia, septicæmia, and chronic renal disease interfere with all reparative processes, and may so retard the cicatrisation of a wounded vessel that on the separation of a ligature bleeding occurs.

2. *Advanced disease of the artery* acts in the same way.

3. *Proximity of a large branch* to a ligature may,

by the rush of blood, impede the formation of an internal clot.

4. *Ulceration and sloughing* in a wound may involve the coats of vessels.

5. *Yielding of a cicatrix* in an artery.

6. *A septic ligature* may excite acute inflammation in the artery, stop all repair, and lead to the separation of a considerable slough.

7. *A badly applied ligature* has a similar effect.

8. *Premature softening of a ligature* may leave the artery too weak to resist the impulse of the blood.

9. *Failure to secure the distal end of an artery*, or of a wound in a branch close above a ligature, may be followed by bleeding when the anastomotic circulation is established.

10. *Plethora, and excited action of the heart*, by increasing the blood pressure, favour the occurrence of secondary hæmorrhage.

Phenomena.—Secondary hæmorrhage is most frequent about the time of the separation of ligatures or of sloughs. The bleeding may occur as a sudden profuse rush of blood, but more often its first indication is the loss of a small quantity only; and this may be repeated in a few hours or a day or two, and life be destroyed by repeated slight losses, or quickly terminated by a more abundant bleeding.

Treatment.—When occurring from a *severed artery*, as in a stump, the best treatment is to open up the stump and to religature the vessel; this is in all cases the safest procedure, but sometimes it is impracticable. Thus, if the parts are sloughy, and a ligature does not hold, the bleeding vessel should be sealed with the actual cautery. In the case of an amputation high up in the thigh, or at the shoulder joint, where union of the flaps is nearly completed, the common femoral or the subclavian artery may be tied. Where religature of the artery in tho stump fails to arrest the bleeding, ligature of the main artery above must be practised. When, on opening up a stump, the blood is found to come oozing out from the whole surface, rather than from one large vessel, the surgeon may try pressure by bandaging the flaps firmly together in apposition, irrigation with cold water, or the frequently repeated application of a styptic. In the case of bleeding from an *artery tied in its continuity*, pressure with a carefully applied graduated compress, combined with compression of the artery above, should first be tried. If this fails, the wound should be opened up and the vessel again tied above and below the bleeding point. If the bleeding recurs, ligature of the artery at a higher point may be tried in the upper limb, but not in the lower; and if that fails amputation is the only resource. In the lower limb, if pressure fails to arrest secondary hæmorrhage from either tibial artery, amputation is the best treatment to adopt at once, as religature of the vessel is impracticable. In the case of the femoral artery, the vessel may be religatured at the wound, and only when this fails is it needful to amputate. To apply a second ligature to the main artery of the lower limb higher up, exposes the patient to a very serious risk of gangrene.

Wounds of Special Vessels.

Of the head and neck.—Wounds of the *internal carotid* artery high up in the neck must be treated by ligature of the common carotid artery. For wounds of the deep branches of the *external carotid*, that trunk should be tied close to its origin: when the bleeding is from one of the more superficial branches an attempt should be made to secure it in the wound. *In the scalp*, free bleeding may be occasioned by partial division of an artery, which is easily arrested by cutting the vessel quite across. Pressure with a simple pad or a graduated compress, or acupressure, are the means to adopt in other cases. Wounds of the *palatine arteries* often bleed very freely; in the soft palate they can be seized with forci-pressure forceps; in the hard palate, if this be impracticable, a ligature may be passed round by means of a fine curved needle and tied; and if other means fail, a peg of ivory or wood may be forced up the posterior palatine canal. In the *tongue*, forci-pressure is the most convenient means of controlling brisk hæmorrhage. A branch of the *dental artery* may give rise to troublesome hæmorrhage after the extraction of a tooth; this is best arrested by removing all coagula from the alveolus, and then carefully plugging it with a narrow strip of lint soaked in perchloride of iron. Wounds of the *vertebral* artery between the transverse processes of the vertebræ can only be treated by very careful and firm plugging of the wound. Great care is required in the diagnosis, for when pressure is made upon the common carotid artery against the sixth cervical vertebra, the vertebral artery is also compressed, and the arrest of hæmorrhage makes it appear as if the bleeding were coming from the carotid or one of its branches. Punctures of the *internal jugular vein* may be treated by seizing the wounded portion of the vessel, and tying it with fine catgut; larger wounds should be treated by the double ligature of the vessel.

Of the trunk.—Wound of the *internal mammary* necessitates ligature of the artery above and below the lesion, and, if necessary, a piece of a costal cartilage must be removed. Wounds of the *intercostal arteries* should, where possible, be treated by ligature or by forci-pressure, and to facilitate this a piece of a rib may be excised. Plugging, when other means fail, may be employed: for this purpose the centre of a piece of linen is introduced between the ribs, and strips of lint are passed into it; the ends of the linen are then drawn tight, and fastened by long pins, and in this way a firm plug is made within the chest, which is pressed outwards against the ribs and the intercostal vessels.

Of the upper limb.—Wounds of the *axillary artery* and its branches should be treated by the double ligature at the seat of injury. Should this be impossible, the subclavian artery is to be tied above the clavicle. Wounds of the *palmar arch* often occasion considerable trouble; both ends of the artery should be tied or crushed, and for this purpose the wound, if necessary, may be cautiously enlarged; in wounds of the deep arch, when it is impossible to seize the vessel, pressure with a graduated compress must be resorted to. To do this the fingers and thumb are bandaged, and the limb fixed to a back splint, and then the point of a conical pad is placed over the wound and firmly bandaged on, and the hand raised across the chest to the opposite shoulder. After twelve to eighteen hours, the pressure on the compress should be removed, and the bandage fixed so as only to secure it in position, and at the same time a piece of gum bougie may be bandaged over the radial and the ulnar vessels at the wrist. Should this treatment fail, these two arteries should be ligatured above the wrist, or the brachial at the bend of the elbow.

Of the lower limb.—Wounds of the *plantar arch* must be treated like those of the palmar arch, the compress being avoided if possible; when ligature of the arteries above is required, it should be practised upon the posterior tibial behind the ankle and upon the dorsal artery of the foot.

XXVI. DISEASES OF BLOOD-VESSELS.

A. Pearce Gould.

Arteritis.

Several varieties of *arteritis*, or inflammation of arteries, may be distinguished.

1. **Plastic arteritis.**—By this is meant the sum of the processes which have been described as leading to the healing of a wound in an artery. (*See* page 364.) It is characterised by exudation of plastic lymph, and its subsequent organisation. According to circumstances, this lymph either seals a wound in an artery, closes the end of a divided vessel, or infiltrates a thrombus, and occludes some extent of the lumen of the tube. In the majority of cases it is associated with similar processes in the sheath of the vessel. The causes of this form of arthritis are non-infective emboli: wounds and contusions of, and the application of a ligature to, arteries. In the majority of cases it is strictly a conservative process, giving rise to no symptoms, and requiring no treatment.

2. **Suppurative arteritis** is a more intense form of inflammation, excited by a powerful irritant. The disease may start from the interior, being occasioned by the presence of an infective embolus or thrombus, or from the exterior, as the result of the extension of acute suppurative inflammation from surrounding tissues. In extreme cases the vessel is destroyed. When only softening of the vessel is occasioned, it is liable to be followed by a bulging of the wall and aneurism. If the coats of the artery ulcerate, hæmorrhage occurs, unless a clot in the vessel extends beyond the area of ulceration.

3. **Chronic endarteritis; arteritis deformans; atheroma.**—These names denote a chronic subinflammatory disease of the arteries which is so common in old persons as to have been regarded as a constant effect of old age.

Causes.—*Mechanical strain* upon the larger arteries is the best established cause of atheroma, hence it is more common in men than in women, and in those whose occupation is laborious, and exposes them to sudden and severe or prolonged effort. *Alcoholic excess* is another well-established cause, which probably acts through the strain put upon the large arteries when the heart's action is excited. *Plethora* acts in a similar manner. The *obstruction* to the flow of blood through the arterioles, caused in chronic Bright's disease by arterio-capillary fibrosis or spasm, increases the tension in the larger arteries, and predisposes to atheroma. *Gout*, by causing renal disease, is frequently associated with chronic endarteritis. *Syphilis* has been asserted to cause atheroma, but the proof of this is not complete. Atheroma is essentially a disease of later life, coming on with the decline of general nutritive vigour. The effect of strain is well shown by the frequency of the disease where arteries are in contact with bone, as along the back of the descending aorta, at the brim of the pelvis, and in the ham, and also around the mouths of the lateral branches of arteries.

Pathological changes.—These commence and are most marked in the tunica intima, which becomes thickened by an overgrowth of its deeper layers, consisting of cells and intercellular laminæ. The middle coat is often not at all affected, but it may be thinned or invaded to some extent by the new tissue of the intima. Changes in the adventitia are more common, consisting of a fibro-cellular thickening which becomes more and more fibroid. The thickening of the intima occurs first in small isolated streaks and patches, and around the orifices of lateral branches of the artery. The affected areas grow at the edge, and usually coalesce with others in their neighbourhood, so that ultimately large areas of a vessel may be involved in the disease. The patches are raised above the surface, are of a glistening semigelatinous appearance, and a firm consistence. Very soon they become yellowish in colour, owing to the fatty degeneration, which is a constant change in atheroma. If this advances rapidly, the disintegrated tissue, consisting now of fatty granules, minute oil drops, and cholesterine crystals, forms a so-called "*atheromatous abscess*," shut off from the vessel by a thin pellicle of intima. This pellicle may be ruptured, and the contents of the "abscess" are then washed into the blood current, and probably block up some small arterioles and capillaries, but, not being injective, give rise to no acute changes in the tissues in which they lodge. An "*atheromatous ulcer*" is then left. In other cases the fatty degeneration of the inflammatory products is unattended with softening, and they persist in the form of raised firm yellow patches. In this tissue lime salts are frequently deposited in the form of plates, which may attain a considerable size.

The calcareous plates are at first covered with the innermost layers of the intima, which are liable to be disintegrated and washed away, and sometimes the edge of a plate is exposed in the vessel. In these cases more or less extensive clots of fibrin may form on them ("thrombosis"); or portions of them may be subsequently detached by the current of blood, and carried into some smaller vessel ("embolism").

Distribution.—Atheroma is most frequent in the aorta and the large arteries. It is less common in the small arteries, excepting those at the base of the brain; it is more common in the arteries of the lower limb than of the upper, and in the splenic artery than in any other artery of the abdominal viscera. It attacks especially the curved parts of arteries and the spots in contact with bones, and frequently is very marked around the apertures of lateral branches.

Effects.—The most constant effect is a *loss of elasticity* in the vessel, which entails a loss of the propelling force of the heart, and renders the vessel liable to yield under the pressure of the blood, and to become elongated and dilated. The dilatation may pass on to the development of an *aneurism.* The occurrence of *thrombosis* and *embolism* has already been noticed; either of these may lead on to *gangrene.* Arteries thus diseased are more liable to *rupture* under the influence of injury than are healthy vessels, and when the affection is far advanced it interferes with the healing of wounds in arteries, and in the distension of arteries which occurs in the establishment of an anastomotic circulation.

Signs.—Well-marked atheroma can be recognised by the elongation and tortuosity of superficial arteries, such as the temporal and the brachial, and by the too marked "locomotion" of the vessel with each pulse wave: the arteries are also less compressible than normal.

4. **Syphilitic arteritis.**—The disease is best known as it affects the smaller arteries, especially of the brain and other viscera. The vessels become thickened, indurated, and irregular in outline. The adventitia shows a moderate amount of a delicate cellular infiltration. The tunica media is generally unaffected; occasionally it is involved by an extension of the disease in the intima. But it is in the intima that the changes are most marked and most characteristic. This coat is enormously thickened, even to the degree of complete occlusion of the vessel. Fine

nuclei and cells appear beneath the endothelium, which multiply and enlarge, and at the same time become separated by fine fibre cells and fibres; as the disease progresses a tissue-like loose granulation tissue is formed, which tends to become more fibrous: new capillaries are developed in it which communicate with the vasa vasorum. The lumen of the artery is narrowed, generally distorted, often converted into a mere slit, and may be entirely obliterated either by the progress of the disease or by the formation of a thrombus. The process is throughout chronic and recurrent.

5. **Obliterating arteritis.**—By this name is known a chronic disease of the intima of arteries, which gradually leads to an obliteration of the vessel. It occurs independently of syphilis, or of other known dyscrasiæ, and probably spreads from the smaller to the larger arteries of a part. It is a very chronic disease, and at first causes severe aching pains, with coldness of the region affected. When the larger vessels are implicated, they are felt to be hardened, at first with a diminished pulse, and then pulseless; subsequently they undergo shrinking. The part is cold, livid on exposure, wasted, and gangrene may occur. The pain may be intense, and at the period of greatest severity pyrexia may be noticed. The disease is a very rare one; it has been noticed in both the upper and lower limb, chiefly in persons of middle life; its cause is unknown, and no special treatment has been recommended for it.

Calcification of arteries.—Calcification is a frequent termination of atheroma, large flat plates often being found in the aorta and other large vessels. This variety is known as *laminar calcification.* Calcareous degeneration is also met with as a primary change affecting the middle coat of arteries of the third and fourth magnitude. The lime salts are deposited in the muscular fibre-cells, and as these run circularly round the arteries, calcareous rings are formed, and hence this variety is named *annular calcification*; when, by the extension of the degeneration, adjacent rings are welded together, it is known as *tubular calcification*. This disease is often associated with atheroma in the larger arteries; it occurs symmetrically, and is a senile change. It can be recognised by the rigidity of the vessels under the finger, and by the irregularities which are felt when the finger is passed along the vessel. By lessening, and then destroying, the elasticity of the arteries it impedes the circulation through the capillaries, and when advanced the lumen of the vessel is narrowed by the thickening of the middle coat. The intima is liable to become detached, owing to the interference with its nutrition by a rigid barrier between it and the vasa vasorum in the adventitia; when this occurs thrombosis is likely to follow; and if from this or any other cause an artery is obstructed, the rigidity of the surrounding vessels greatly impedes the establishment of an anastomotic circulation. The common effects of the degeneration are coldness of a part, and slow wasting; ill-defined pains are sometimes assigned to it. Its real importance is in connection with senile gangrene, arterial thrombosis, and the establishment of anastomotic circulation.

OCCLUSION OF ARTERIES IN THEIR CONTINUITY.

Causes.—An artery may be occluded as a result of injury or disease. It has already been stated that complete division of an artery or an extensive wound in it is followed by the permanent closure of the vessel. The partial or complete rupture of an artery, or the application of a ligature to it, has the same effect. Arteritis obliterans slowly accomplishes the same end. Disease of the vessel leading to the formation of a thrombus, or the impaction of an embolus brought from a distance, also leads to the closure of an artery, unless suppurative arteritis is excited. Arteries are also often occluded by the pressure of tumours or of contracting cicatrices.

Effects.—The simplest case in which to study the effects of arterial occlusion is that of the ligature of a vessel in its continuity. The first effect is a blanching of the part with a loss of all pulsation in the arteries arising below the ligature. The part quickly becomes cold and benumbed, and if from the extent or position of an arterial obstruction, or from disease of the vessels, an anastomotic circulation is not established, the part dies, undergoing the changes described as "dry" gangrene. More usually blood is carried into the empty vessels by the numerous arterial anastomoses that exist almost universally in the body. When this first occurs all the communicating vessels participate; but gradually certain special channels enlarge, often considerably, and serve as the main channels for the blood, while the others contract to their normal size. The temporary deprivation of blood causes the vessels beyond the ligature to yield to the pressure of the blood first brought to them through the anastomosing channels, and thus the

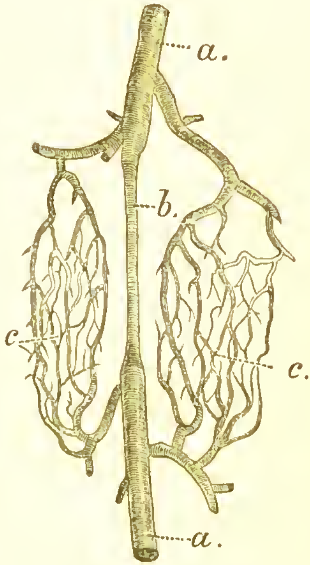

Fig. 17.—Showing effects of Ligature of Femoral Artery.

a, Femoral artery of a dog; *b*, obliterated portion of artery; *c*, *c*, anastomosing vessels in sartorius and pectineus. (After Porta.)

pallor and coldness first noticed are followed by increased redness and heat in the part; which gradually subside as the tissues resume their full vitality. Finally, the part is generally left a little shrunken and cold, owing to the blood supply being below the normal. If vessels are very atheromatous, or are calcified, they are unable to undergo the required enlargement; and when a considerable extent of a vessel is obstructed it may be impossible to carry blood into the parts below the obstruction; in these cases "dry" gangrene occurs. When venous obstruction is superadded, the force of the heart, which is largely dissipated in propelling the blood through the anastomosing arteries, may be unable to accomplish the return of blood from the part; in that case "moist" gangrene results.

Symptoms.—When due to embolism this occurrence is often marked by an acute pain, and the empty vessels beyond may be tender to the touch; the sudden occurrence of the occlusion, the absence of other causes, and the detection of some source of the embolus such as valvular disease of the heart, are the factors in the diagnosis. When due to a thrombus, the symptoms come on soon after a contusion of the artery or in connection with advanced disease of the vessel; when due to the pressure of tumours, the arterial occlusion is gradually brought about, and the loss of the pulse in the vessels follows upon its slow diminution in force and volume. When this is the case the effects of the arterial occlusion may be slight, or nil.

Treatment.—The limb or part should be placed in the position most favourable for the circulation of blood, should be carefully protected from all sources of irritation, and should be lightly swathed in cotton wool.

DISEASES OF VEINS.

Inflammation of the coats of a vein is called *phlebitis;* this, when it affects the intima, always causes clotting of the blood in the vessel (*thrombosis*); it was at one time held that the presence of a clot in a vein was evidence of inflammation of its coats, and, therefore, every instance of venous thrombosis was classed under one or other division of phlebitis. It is now known that a thrombus may form in a vein independently of inflammation of its walls, and subsequently excite phlebitis. The two subjects of *thrombosis* and *phlebitis* must therefore be dealt with separately, although the reader will readily perceive the close relation between the two and their frequent combination.

Thrombosis.—A clot formed within a vessel during life is known as a *thrombus*, and the process of its formation, as well as the disease it characterises, is called *thrombosis.*

Causes.—The causes of thrombosis may be ranged under two heads :

(*a*) *Changes affecting the physiological integrity of the walls of veins.*—These are *injuries* such as incisions, contusions, lacerations, or even mere exposure in a wound ; *inflammation* of the wall of a vein, whether spreading to it from outside or lit up in it by an infective embolus or thrombus ; *degenerations*, which are much less frequent in veins than in arteries, and chiefly occur in connection with varices ; and possibly also from *blood stasis* and *exhaustion.*

(*b*) *Changes affecting the physiological integrity of the blood*, particularly of its white corpuscles. These are much less clearly known. The artificial introduction of a sufficient quantity of "fibrin ferment" into the circulation has been shown to cause wide-spread coagulation; and it is believed that in such constitutional states as septicæmia and pyæmia a similar liberation of "fibrin ferment" occurs and induces the multiple thromboses met with in these diseases. Other blood states may have a similar effect, and the thrombosis attributed to exhaustion, and to stasis, may be in part accounted for in this way. The action of foreign bodies in the blood stream, such as a pin or ligature transfixing a vein, emboli and existing thrombi, and micrococci, is of the same nature.

While these may be regarded as the pathological causes of thrombosis, certain clinical causes must be separately considered. Of these the most important is *interference with the circulation of the blood*, especially when it amounts to stasis. Slow movement of the blood or complete rest retards coagulation out of the body, but during life it is attended with a lessening of the amount of oxygen in the blood, and a torpid flow through the vasa vasorum, each of which may be sufficient to account for the occurrence of coagulation. It has also been supposed that the constant movement of the blood over perfect endothelium is in itself one of the means of preventing the formation of fibrin. Retardation of the venous flow is caused by weak action of the heart, loss of elasticity in the arteries, dilatation of the veins or obstruction to the emptying of a vein, whether from a previous thrombosis, constriction by a ligature or tight bandage, compression of tumours or inflammatory exudations or cicatrices, or disease of the heart or lungs. Compression of a vein, as of the femoral in long continued flexion of the hip joint, may be followed by thrombosis.

The influence of *exhaustion* is often witnessed. Thus in the later stages of phthisis and other suppurative diseases, after typhoid or rheumatic fever, or after severe operations, thrombosis is not infrequent.

The slowing of the circulation due to the weak action of the heart, and the diminution in the quantity of the blood, and the diminished vitality of the vessel walls, and probably also of the white corpuscles themselves, are the causes of the coagulation. These factors also lead to the extension of a clot caused primarily by a strictly local process such as ulceration.

The clotting that occurs in wounded veins, in suppurative phlebitis, or around a softening clot, is a valuable conservative process.

Varieties of thrombus.—When blood at rest coagulates all the corpuscles, both red and white are enclosed in the meshes of the fibrin, and the clot is red in colour and is known as a *red thrombus*. On the other hand, when the blood is in rapid motion and the focus of coagulation is small, as in the case of a puncture in the coats of a vein, or a thread transfixing it, the white corpuscles at first adhere, and the fibrin, as it forms, encloses them alone, and the clot is of a grey colour, and is known as a *white thrombus*. As such a clot extends, some of the red corpuscles may be caught in it, and impart to it a deeper colour, and so all grades between the "white" and the "red" thrombus are seen. Sometimes alternate layers are deposited, or a "white" thrombus grows until it occludes a vein, and the stasis above and below leads to its being sealed over at each end by a "red" thrombus; these clots are generally known

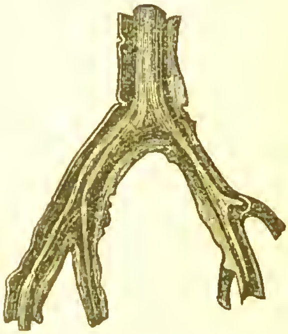

Fig. 18.—Thrombosis of Vena Cava and Iliac Veins.

as *mottled thrombi.* The colour of the clot, therefore, enables us to judge of its mode of formation.

The changes occurring in a thrombus vary in different cases, and upon these the importance of the condition very largely depends.

1. *Organisation.*

2. *Calcification*, the product being known as a *phlebolith.* Phleboliths are usually small, being formed in clots behind valves in varicose veins, and in the branches of the pelvic plexuses of veins. They may lie free in the channel of a vein, being attached to its wall by a narrow pedicle, or they may mark the site of an occluded vessel. They are composed chiefly of phosphate of lime, with a small quantity of the sulphates of lime and potash, together with about twenty per cent of proteid matter.

3. *Softening.*—The softening is described as of two kinds, "red" and "yellow." A blood clot may be changed into a greyish-red pulp, the softening commencing in the centre and gradually extending, and the same process may occur on the tip of a projecting thrombus, the products of the disintegration being removed as soon as they liquefy; the detritus may be arrested in the pulmonary capillaries, but being unirritating, give rise to no symptoms. "Puriform" or "yellow" softening is much more serious, and probably always occurs as a result of the action of septic micrococci; it is, therefore, met with in infective thrombi, and in thrombi formed in veins attacked with septic inflammation. The clot breaks down into reddish-yellow or pus-like creamy pulp, consisting of granular detritus, some pus cells, and micrococci. Such softening is always associated with septic phlebitis, either as cause or effect.

4. *Restoration of the channel.*—The channel of a plugged vein is often restored when the clot is non-infective. This may happen from (1) red softening of

the thrombus; (2) organisation of the thrombus with dilatation of the vessels in the new-formed tissue; (3) contraction of the thrombus to one side of the vein; the vessel then looks as if it was thickened at one part; (4) canalisation of the thrombus; from the contraction of the clot spaces in it are formed which coalesce, open into the vein above and below, and then still further dilate under the pressure of the blood.

Embolism may result either from a portion or the whole clot being dislodged, or from softening of the thrombus. Its effects depend upon the nature of the embolus, whether infective or simple, and upon its size and place of arrest.

Extension of the thrombus.—A simple traumatic thrombus is often limited to the extent of the vessel that is injured. It may extend up and down as far as the next branch, where the rapid flow of blood appears to stop the coagulation. But in other cases clotting extends, usually in the direction of the venous flow.

Effects of thrombosis.—The first effect is obstruction to the venous return, followed by œdema; in many cases phlebitis is added. The closure of a vein is followed by the establishment of an anastomotic circulation, which may be so perfect that the leg or other part is restored to its original function, or merely swells a little after prolonged exercise; the failure to establish such a circulation exposes the patient to the risk of "moist gangrene."

Symptoms.—The symptoms of thrombosis are local œdema and the detection of a firm cord-like swelling in the course of a vein. The cylindrical swelling caused by the distended vein is bulged opposite each valve; it is tender to the touch; occasionally superficial veins are dilated. The patient feels the part to be stiff, and movement is painful.

Thrombosis is most common in the lower limb, and especially in the saphena vein.

Treatment.—As in phlebitis.

Plastic phlebitis is an inflammation of the coats of a vein, attended with effusion of plastic lymph, terminating in resolution or obliteration of the lumen of the vessel.

Causes.—Injuries; the formation of a simple non-infective thrombus; the extension of plastic inflammation of the tissues around a vein; gout, and certain other unknown conditions which occasion so-called "idiopathic phlebitis."

Pathology.—The coats of an inflamed vein are swelled and softened by a cellular exudation infiltrating the media and adventitia. The disturbance in the nutrition of the intima always leads to thrombosis when that is not the primary change. Generally the vessel then undergoes the same changes as occur in the permanent closure of a wounded artery; but in some cases the inflammation subsides, and the vein is again restored to its former state. Traumatic plastic phlebitis is limited in extent to the injured part of the vein, and has no tendency to spread; and the same is true of the inflammation excited by the presence of a simple thrombus. Gouty phlebitis is usually symmetrical, often subsides in one vein to light up in another, and has a tendency to recur in the same vessel. Phlebitis may attack any vein, but it is most common in those of the lower limb, and especially in the saphena veins.

Symptoms.—The symptoms are primarily those of thrombosis; there is a firm knotty cord in the position of a vein. The part is painful and tender, the skin over an inflamed superficial vein is reddened, and pits on pressure.

Treatment.—The part should be kept at rest, and raised so as to favour the venous return from it.

Heat relieves the pain and favours resolution, and a good local application is belladonna and glycerine thickly smeared over the part, and then a hot fomentation. The bowels should be unloaded by a saline purge, and the diet restricted to fluids, bread, and fish. When the inflammation has subsided, if œdema persists a bandage should be worn. In gouty phlebitis alkalies and colchicum should be exhibited.

Suppurative Phlebitis.

Suppurative phlebitis.—Causes. The cause of suppurative phlebitis is probably in all cases infection with putrefactive organisms. Hence, if the thrombus in a wounded vein becomes infected with septic micrococci from the discharges in the wound, or the coats of a vein are bathed in putrid fluid, or when the tissues around a vein or returning blood to a vein are attacked with septic inflammation, this form of infective or suppurative phlebitis is set up. It occurs in connection with septic wounds, diffuse cellulitis, and "acute necrosis," and it plays an important part in many cases of septicæmia and pyæmia.

Pathology.—The changes in the coats of the vein are those common to suppurative inflammation. The changes in the thrombus are those already described as "yellow softening," and the products eventually blend with those of the disintegrated vessel itself. Septic micrococci are always found both in the softened thrombus and in the disintegrated vein wall. The disintegration of the clot is commonly attended with the escape of septic embolisms into the general blood stream, and septic phlebitis is commonly a link in the chain of processes ending in septicæmia and pyæmia. The infective nature of this form of phlebitis imparts to it one of its chief peculiarities, its tendency to spread, which is so marked that it is often known as "spreading phlebitis."

Symptoms.—In many cases suppurative phlebitis gives rise to no symptoms by which it can be recognised, but the occurrence of septicæmia or pyæmia in connection with a wound or ulcer is the first indication of such a lesion. Abscesses occurring in the course of septic inflammations are in many cases the result of suppurative phlebitis, and the secondary abscesses of pyæmia are believed to be in some cases of the same nature. When the disease attacks a superficial vein it can be more readily recognised. In such a case the vein is converted into a firm cord with projecting "knots" opposite each pair of valves; the outline of the vein is quickly lost owing to surrounding œdema, and the skin over the part reddens; then at one or more spots (often at the valves) the swelling notably increases and becomes fluctuating; meanwhile the disease involves more and more of the vein.

Treatment.—The only successful treatment of this condition is preventive; rarely are remedial measures successful in saving life. Abscesses formed in the course of the affection should be opened early, and the cavity cleaned with carbolic acid or corrosive sublimate in solution. Where the disease is recognised early and before there are signs of general blood poisoning, the part should, if possible, be amputated well above the plugged vein; but it is only rarely that such a case presents itself to the surgeon. The preventive treatment is the efficient application of the methods of aseptic surgery to wounds of all kinds. In "acute necrosis," abscess should be opened early, and with antiseptic precautions, but even this may fail to prevent infection of a vein. The constitutional treatment is that of septicæmia.

VARICOSE VEINS.

A permanent pathological dilatation of a vein is called a *varix,* and a vein so affected is said to be *varicose.* The disease is most common in the veins of the lower extremity, but is also frequently met with in the spermatic cord (varicocele), and around the anus (hæmorrhoids), less often in the neck, upper limbs, and trunk. It is chiefly observed as a disease of the subcutaneous veins, but dissection shows that it affects very often also the intermuscular and intramuscular veins, but the main veins of the limbs with the exception of the posterior tibial vein are remarkably exempt from it. The disease may be limited to one or more of the main superficial veins, as either saphena, or even to a limited portion of it; or leaving these veins free, it may involve only some one or more branches opening into them, or some of the small venous radicles only, and then again, in other cases, all the subcutaneous veins of a part are found to be varicose. It is believed that a superficial varix often commences at the point where a deep vein communicates with a superficial vessel, and that the dilatation of a varicose vein is apt to be most marked at such situations. The coats of varicose veins are notably thickened, so that when cut they gape like arteries. The intima is thickened and shows longitudinal

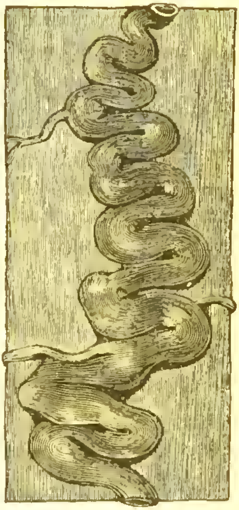

Fig. 19.—A varicose Vein.

striæ; sometimes it is atheromatous or even calcified. In the middle coat there is an increase of both the muscular and the fibrous elements; the outer coat is also thickened to a less degree; but firm bands of fibrous tissue bind together the convolutions or a tortuous vein, and also fix it to the skin over it. The valves of varicose veins are not enlarged in a compensatory manner, but, on the contrary, may be found shrunken, or present in the form of cords, adherent sometimes by one end only, or they may be entirely wanting.

Etiology.—The usual view is that varix results from a disturbance in the normal relation between the intravenous pressure and the resistance of the vein wall; this may be either an increase in the blood pressure or a diminution in the tone of the vessel. The diminished power of resistance of a vein may be an inherited condition, or the result of some occult error in development; or it may result from absorption of surrounding structures depriving the vessel of its wonted support; or from inflammatory changes in the outer coat of a vein leading to its softening. Increased intravenous pressure is generally considered to be a more powerful factor. This may result from the action of gravity obstructing the venous outflow, or from an increased supply of blood to the part. The pressure of a pregnant uterus upon the iliac veins is believed to be a common cause of varicose veins of the leg; the pressure of a tight garter or of an ill-fitting truss, and the obstructive diseases of the heart and lungs, are other conditions which may have the same effect. Although the column of blood in the veins of the lower limb is supported by that in the arteries, yet the pressure of the blood upon the vessels is increased by gravity, and is greatest at the lower end of the column. The valves are of use in breaking up the veins into segments, each of which is to some extent relieved from the weight of the column of blood above it. But should a valve be rendered useless by over-distension of the vein or any other circumstance, the segment below is not thus relieved, and is liable to yield under the extra strain thrown upon it. The hyperæmia attending inflammation, chronic ulceration, or prolonged muscular contraction increases intra-venous pressure. Certain etiological factors must be still further considered.

(*a*) *Age.*—Varicose veins most often develop between twenty and thirty-five years of age; they may increase or diminish at later periods.

(*b*) *Sex.*—The disease is more common in men than in women, probably because, with the exception of pregnancy, they are more exposed to the exciting causes of varix.

(*c*) *Occupation.*—All occupations which entail prolonged standing or walking predispose to the disease; this is partly due to the effect of gravity, partly to the compression of the deep veins by the contracted muscles, and partly to the active hyperæmia attending prolonged muscular action.

Effects.—It is commonly held that the dilatation of veins impedes the return of blood from a part; this leads to chronic congestion and œdema, with ulceration, eczema, and induration of the tissues as results. The frequent association of these latter conditions with varicose veins is a fact, but that they are related as cause and effect is highly improbable. Certain is it, that even in cases of extreme varix no one of these phenomena may be observed, while they are often met with apart from varix. Possibly they may be common results of one set of causes. The dilatation of a vein is sometimes attended with a thickening and pigmentation of the skin over it; more often, however, the skin is thinned by the constant pressure; and when, as may happen, this is combined with a thinning of the coats of the vein, the vessel may burst externally, either spontaneously, or as a result of strain or some local injury. The thinning of a vein chiefly occurs at the seat of saccular dilatations of its walls. The altered state of the vein walls, and the slowing of the circulation within them, together with their prominence exposing them to contusion, render varicose veins specially liable to thrombosis.

Symptoms.—An extreme degree of varix may exist without giving rise to any symptom. More usually the patient complains of an aching pain, or a sense of fulness in the part on standing, or after long walking. Deep varix may cause cramp-like pains. The enlarged veins are readily recognised; often their blue colour is visible. In the skin, dilated veins show as blue lines; they are often arranged in a stellate manner. Great thinning of a vein gives it a dark purple colour, and its rupture leads to free hæmorrhage, for, owing to the inefficiency of the valves, the venous blood flows both from above and from below.

Treatment is either palliative or curative.

Palliative treatment consists in obviating the increased intravenous pressure caused by position, strain, muscular action, etc., in affording external support to the vessels by well-fitting elastic stockings, or a carefully applied bandage, and in improving the patient's general condition by astringent tonics or digitalis, where these are indicated.

The curative treatment consists in obliterating or removing the diseased vessels. It is indicated in only a minority of cases; the multiplicity of varices, and the simultaneous affection of deep veins, frequently render operations performed upon superficial veins disappointing. Where, however, a single limited varix exists; or one particular varix is a source of constant pain, unrelieved by palliative treatment, and disabling the patient; or where an enlarged vein leads directly up from a chronic ulcer, which resists other measures, operative treatment of the varix is called for. Many modes of radical cure have been proposed, but only three require notice.

1 **Acupressure.**—By passing a hare-lip pin beneath the vein, placing a piece of gum bougie over the vessel, and then throwing a silk thread in a figure of 8 over the ends of the pin, the walls of the vessel can be held in apposition, and a certain amount of traumatic phlebitis be excited, which may lead to the occlusion of the vessel. One or many pins may be employed, as may be required; they should be withdrawn in about a week, unless marked irritation be excited earlier, and they may be left longer if the local irriation be very trivial. Care should be taken not to pierce the vein, as it is liable to excite more acute phlebitis. The operation often fails to obliterate the vein. Two pins may be introduced close together, and the vein then be divided subcutaneously; this renders the result more certain.

2. **Ligature.**—Through an incision, about half an inch long, down to the vein, a ligature may be passed around it and tied. Silk, soaked in carbolic acid solution (five per cent.), is the best material for the ligature; chromic catgut may be used.

3. **Excision.**—By making an incision along a varix the vein may be exposed and dissected out; a double ligature should be tied around each branch of the vessel before it is divided. All these plans of treatment should be performed with antiseptic precautions, lest spreading phlebitis be excited. Intravenous injections of perchloride of iron, or carbolic acid, or the application of the actual cautery, or hot iron, are not to be recommended. Where a single bunch of

varicose veins demands treatment, excision is the best operation; where it is desired to cure a number of varices, or one of considerable length, the multiple antiseptic ligature is to be employed, or if the surgeon prefers it, acupressure.

ANGEIOMATA.

Angeiomata are tumours composed mainly or exclusively of blood-vessels; some of these vessels are newly formed, others are pre-existing ones, dilated more or less extensively. The vessels may be arteries, capillaries, or veins. Arterial angeioma is more often known as *cirsoid aneurism*; capillary and venous angeioma are commonly called *nævi*, or "mother's marks." Cases are sometimes met with in which two or more of these varieties of angeioma are combined together; they are classified in accordance with the predominant character of the tumour.

Arterial varix; cirsoid aneurism; aneurism by anastomosis.—These names are applied to various conditions of dilated and elongated arteries. When a single large artery is lengthened, tortuous, and pouched like a varicose vein, it is known as an *arterial varix.* When this condition affects several vessels, giving rise to a tumour composed of a congeries of dilated arteries, it is called a *cirsoid aneurism.* When the condition of vascular dilatation has spread from the arteries to the capillaries and venules, it is known as *aneurism by anastomosis.* This disease is much rarer than venous varix; it is generally met with on the scalp, most frequently affecting the superficial temporal, posterior auricular, and occipital arteries, though it may occur in the orbit and other parts. In some cases it follows injuries, such as cuts, bruises, and burns, and on this account has been considered inflammatory in nature. In other cases it has supervened upon a congenital erectile tumour or venous nævus, arising spontaneously (sometimes at puberty) or as a result of injury. It most often commences between puberty and thirty years of age.

Pathological changes.—The arteries are considerably dilated, pouched, and greatly convoluted. Their walls are thinned, chiefly by the atrophy of the middle coat. The skin over them and the other soft tissues may be thickened and spongy, but are often thinned, and the seat of ulcers, which, by extending to the arteries, occasion very severe hæmorrhage. Subjacent bone may be grooved or even perforated by the enlarged vessels. The arteries leading to a cirsoid aneurism are varicose, and the disease tends to spread both centrally and towards the capillaries.

Symptoms and course.—Occasionally a single very enlarged tortuous artery is to be traced in the scalp or other part (*arterial varix*), but more often the disease assumes the form of an irregular ill-defined swelling. The part is hotter than natural, of a dull blueish colour, and exhibits a strong expansile pulsation, with a distinct thrill and a loud rasping, cooing, or musical bruit. The skin over it may be thin or thickened. Several dilated arteries can generally be traced leading to the tumour, and this renders the outline of the swelling ill defined. By compression of the enlarged arteries feeding the "aneurism," the pulsation is lessened, and the thrill sometimes made to disappear. The patient is often conscious of the bruit in the tumour. The tumour may remain stationary and cause little inconvenience, or in very rare instances it may undergo spontaneous cure. More often it continues to enlarge, involving more and more vessels; or it ulcerates, and gives rise to bleedings which gradually exhaust the patient.

The diagnosis is usually very easy. From common aneurism it can be distinguished by its position, outline, compressibility, and the state of the vessels feeding it. The character of the murmur and the effects of compression of the main artery also differ in the two cases. Cirsoid aneurism following upon an injury might be mistaken for a varicose aneurism, especially as the bruit and thrill, and the enlargement of many vessels, are somewhat alike in the two cases; but the tumour formed by a cirsoid aneurism is less well defined, and its pulsation is not arrested by compression of a single arterial trunk.

Treatment.—When not increasing in size, or threatening to ulcerate, or giving grave distress to the patient, no operative treatment should be undertaken, but the part should be protected by a metal plate, or some similar appliance. When the tumour is growing, or hæmorrhage has occurred or is threatened, its cure should be attempted. If the tumour is small and fairly well defined, it should be excised or strangled by a ligature, like a nævus (*see* page 407); if excision be practised, each feeding artery should be tied as it is cut, and the surgeon should be careful to keep well outside the limits of the tumour itself; neglect of either of these precautions may lead to serious or even fatal hæmorrhage. Where the affection is more diffuse, or so situated that excision is impracticable, three courses (named below) are open, but their success is not certain. In many cases entire failure has attended them; in others, after temporary improvement the tumour has developed again. The difficulty in dealing satisfactorily with this disease arises from the fact that the aneurism is fed by many vessels, and cutting off the supply of blood from one or even several sources does not starve it, while the tendency to spread and involve more vessels is one of its most marked features.

1. *Ligature of the feeding vessels* has never yet been successful; but when combined with division of the parts between the feeding arteries has in a few cases effected a cure.

2. *Ligature of the main artery* of the part. The common carotid artery has on several occasions been tied for cirsoid aneurism of the scalp, but with only a limited degree of success : ligature of both external carotid arteries is a safer operation, and more effectually starves the growth, and it is therefore to be preferred.

3. *Injection of perchloride of iron* has been practised, especially on the continent, and with considerable success; a temporary ligature is thrown around the tumour while the coagulating fluid is injected and until the clot is firm. *Galvano-puncture* has also been used with success.

NÆVUS.

Structure.—A "simple," "capillary," or "plexiform" nævus is composed of a group of dilated, tortuous capillaries, with their nucleated walls held together by a small amount of connective tissue. A "venous" or "cavernous" nævus, also called "erectile tumour," is formed of a series of intercommunicating spaces lined with endothelium like that in veins; between the spaces is a variable amount of fibrous or fatty tissue, but the blood is not surrounded by proper vessel walls. The arteries pour their blood direct into these blood spaces, and from them normal or somewhat enlarged veins take their origin.

Etiology.—Most nævi are congenital; some are first noticed a few days after birth, others appear to originate about puberty, and in some instances their development follows upon an injury.

Clinical characters.—Capillary nævi chiefly occur in the superficial layers of the skin, and particularly on the head, face, neck, and chest; venous nævi develop beneath the skin and mucous membranes, being common in the scalp, lips, and cheek, on the trunk, and in the female genitals; they are also met with in the tongue, breast, and rectum, and in the liver, growing in that organ late in life. Nævi are single or multiple, and the two forms are often associated in a single tumour. *Capillary nævi* may appear as minute bright or darker red specks in the skin, or as larger growths: if the dilated capillaries form but a very thin layer they are commonly spoken of as "port-wine marks;" where the vessels form a thicker layer in the skin, the tumour projects slightly, and is often granular on the surface. The outline may be clearly defined, or broken up by smaller spots around a central nævus. If of large size the surface may be felt to be hotter than the surrounding skin; the colour may be lessened by pressure, but returns very quickly. *Venous nævi* form soft easily compressible tumours of irregular, lobulated, or tortuous outline, which become full and tense under the influence of crying, coughing, or straining. When of large size they often show a tendency to become pedunculated. Beneath mucous membrane or thin skin they show a purple colour, which is intense when the growth implicates the skin itself. Large veins may be seen coursing from the tumour; the skin over them may be the seat of capillary nævus.

Beyond the fact of disfigurement, nævi rarely occasion any ill effects. If cut they bleed freely, but the hæmorrhage is easily controlled by pressure. They may remain stationary throughout life or may steadily increase; or, having remained stationary for a time, suddenly, whether from the effects of injury or the stimulus of puberty, take on an active growth. Nævi may become more prominent at the menses, and they have been known to be the seat of vicarious menstruation. Puberty sometimes arrests their growth. On the other hand, nævi may undergo retrogressive changes. The centre becomes gradually paler, and this change extending may remove the entire disease; in other cases the tumour ulcerates and leaves a white cicatrix. In some instances of venous nævus blood cysts develop, owing to the shutting off of a blood space and its subsequent distension; in other cases a warty growth has replaced a nævus. A combination of venous nævus with lipoma is met with as a congenital tumour, called *nævo-lipoma.* A capillary nævus cannot be mistaken for any other affection, while the spongy feel, compressibility, distension under effort, and, in many cases, the colour of venous nævi, render their recognition easy. The absence of pulsation, thrill, or bruit, distinguishes them from arterial angeioma.

Treatment.—Nævi undergoing natural cure, or which are stationary and on parts of the body covered by clothing, or superficial nævi of wide extent, as many "port-wine stains" are, should not be subjected to any treatment. Nævi on exposed parts of the body, with the exception of large "port-wine marks" and all growing nævi, should, if possible, be cured. Very superficial nævi are easily destroyed by nitric acid or acid nitrate of mercury; if extending a little deeper, the repeated application of the caustic will suffice to remove them, or they may be burnt by a fine cautery. For venous nævi the surgeon has a choice of several methods of treatment; the objects in view being the complete obliteration or destruction of the growth with a minimum of scar.

1. **Excision.**—The tumours are usually surrounded by a capsule, and, if care be taken to make all incisions outside this capsule, their removal is easy and free from risk of hæmorrhage. This method is particularly applicable where primary union of the wound with a linear cicatrix can be obtained; it is less painful than ligature, and recovery is more rapid.

2. **Ligature.**—Almost any nævus can be strangled by a ligature. On the separation of the sphacelus the

wound left quickly heals. Care should be taken to include the whole of the nævus in the loop or loops, which should be tied as tightly as possible; strong waxed silk or whip-cord should be used. In no case should the ligature be made to cut its way through skin, but the thread should be subcutaneous or the skin divided with a knife. When the nævus is entirely subcutaneous the ligature should also be subcutaneous, if possible. The advantages of the ligature are its simplicity, safety, and efficiency; the disadvantages are the scar left when the skin is involved, the pain, and the duration of the treatment.

3. **Injection of coagulants.**—Perchloride of iron, a solution of tannin, or pure carbolic acid may be used. Owing to the danger of embolism, this plan must only be adopted when a temporary ligature can be placed around the tumour and left on for a quarter of an hour after the injection. When successful it leaves little or no scar. If more than a few drops of the iron solution be thrown in it exerts a caustic action.

4. **Electrolysis.**—If two needles, insulated to within half an inch of the point, be passed into a nævus on opposite sides, and a constant electric current, such as is obtained from ten cells of a Stöhrer's battery, be passed through them, it may cause coagulation of the blood and obliteration of the tumour. The current should not be strong enough to cause bubbles of gas to appear, and as soon as the tumour becomes blanched or hardened the direction of the current should be momentarily reversed, and then the needles be removed. This treatment, when successful, causes no scar. It may require to be repeated many times.

5. **Seton.**—Simple threads of silk, or silk soaked in solution of perchloride of iron, passed across a nævus and left in position for about a week, excite inflammation along their track, which obliterates the

vascular spaces. This treatment is adapted for cases of diffuse nævus, or in situations where excision, ligature, and injection are alike impracticable.

Vaccination of nævi is sometimes successful. Superficial nævi are inoculated by slight abrasions of the surface, and the development of the vaccine vesicle obliterates the vascular growth. Vaccine lymph may be introduced on silk threads into subcutaneous nævi to excite obliterating inflammation. Painting on ethylate of sodium has been recommended for superficial nævi.

"Port-wine stain."—The treatment of this disfigurement is very unsatisfactory. Caustics and multiple scarification are the means that have been used. Large "stains" should be left alone.

XXVII. ANEURISM.

A. PEARCE GOULD.

AN aneurism is a blood tumour communicating with an artery. Such a tumour may develop as the direct result of an injury (*traumatic aneurism*), or follow upon previous disease of the vessel wall (spontaneous or *idiopathic aneurism*). These two great classes of aneurisms differ very materially both in their origin, nature, and appropriate treatment.

SECTION I. IDIOPATHIC OR SPONTANEOUS ANEURISM.

Etiology.—A spontaneous aneurism is formed when from any cause an artery permanently yields under the blood pressure to which it is subjected. Healthy arteries have such a reserve of resistance that simple increase of blood pressure from plethora, over-action of the heart, or resistance to the capillary circulation, never by itself causes aneurism. When, however, the resisting power of an artery is lessened, it may yield under the normal blood pressure, and still more readily if that is exaggerated. The causes of spontaneous aneurism are therefore to be grouped under two heads: (1) conditions which weaken the arterial walls, and (2) conditions which increase the arterial blood pressure; of these, the first is essential and the second only accessory.

1. **Conditions weakening the arterial walls.**—By far the most important of these is *atheroma* with fatty degeneration of the inflammatory products. The formation of calcareous plates in arteries preserves them from aneurismal dilatation,

although, as we shall see, such plates may sometimes be found in aneurisms.

Embolic arteritis. — As already described, the impaction of an embolus in an artery may excite inflammation of the vessel wall, and so soften the vessel as to make it yield under the pressure of the blood.

Loss of support by absorption of the surrounding tissues.—Examples of this are chiefly met with in the branches of the pulmonary artery lying in the walls of phthisical cavities. In such cases, and particularly when the cavities are contracting, aneurisms not unfrequently develop, and their rupture is a frequent cause of fatal hæmoptysis.

2. **Conditions increasing the blood pressure.**—Of these the most important is *effort* or *strain*, particularly when sudden, intermittent, or unwonted.

Increased cardiac action, either from hypertrophy, or the stimulus of alcohol, or mental or moral excitement, is another similar condition.

Plethora and resistance in the arterioles also increase the arterial blood pressure. The mere maintenance of the power of the heart at its normal level in association with degeneration of arteries may be sufficient to produce aneurismal dilatation. The greater frequency of aneurism of the aorta than of any other artery is due to the greater pressure of the blood in this vessel.

3. **Certain secondary causes** must be further mentioned. *Age.*—Aneurism is most common between the ages of thirty and fifty : at the time when degenerative changes occur in arteries, and before the force of the heart is diminished, and when persons are still exposed to strains and injuries. When occurring in children and young adults, it is generally, perhaps always, the result of embolism. *Sex.*—Dissecting aneurism is more common in women than in men.

Carotid aneurism is equally common in the two sexes; but other forms of aneurism are much (thirteen times) more common in men than women, because they are more exposed to the exciting causes of the disease.

Occupations which expose to sudden effort, such as that of soldiers and sailors, predispose to aneurism by the sudden increase of the blood pressure, and laborious occupations which constantly throw a strain upon the circulation predispose to atheroma. Thus it is that aneurism is most common in cold and temperate regions, and especially in Great Britain.

Injury and strain.—A local injury not uncommonly precedes the development of an aneurism, for it may excite the inflammatory changes of atheroma, or burst an atheromatous abscess, or cause a partial rupture of the arterial coats and their consequent yielding. Strain acts in several ways. (1) By increasing the heart's action; (2) by increasing the capillary resistance in the muscles; (3) by stretching or compressing an artery, and so exciting atheroma in it, strains at the knee thus act upon the popliteal artery. *Alcoholism* causes aneurism by inducing atheroma and recurrent cardiac excitement.

Diathesis.—The extent of the influence of syphilis is doubtful (*see* Atheroma, page 382); that of gout and rheumatism is more certain; cachexy may predispose to atheroma, but to the extent to which it lessens the heart's power it protects from aneurism. Aneurisms are sometimes multiple, and the patient is then said to exhibit the "aneurismal diathesis." Such cases are, however, to be explained by the fact that the causes of aneurism are to a large extent general rather than local, and in view of this the frequent occurrence of one aneurism only is that which specially demands explanation.

Development.—When a given portion of an artery yields, the whole circumference of the tube may be affected, or merely some limited part of it. In the first case the vessel expands both longitudinally and laterally, generally in a more or less fusiform manner. All three coats of the artery yield; but dissection shows that while the outer coat is stretched, and thickened by newly formed fibrous tissue, and the inner coat is thickened and uneven from atheroma, the middle coat shows no similar change, but the muscular fibres are separated as the result of the stretching, and often undergo fatty degeneration. In such a case the whole circumference of the vessel is uniformly diseased, although in different parts it may show various degrees of atheroma, and calcareous plates may be found in places. As this uniform disease of arteries is mainly met with in the aorta and largest arteries, this form of aneurism, called tubular or fusiform, is met with there only. When any part of the wall of a fusiform aneurism is specially weakened, it may yield quite out of proportion to the rest, and develop a sacculated aneurism; this combination of the two varieties is not uncommon in the aorta. Localised yielding of an artery is due to the weakening of the artery being limited to or much greater in one particular spot in the wall. This may be a patch of atheroma that has undergone fatty degeneration; the weakened part of the vessel yields and bulges externally, all the coats participating at first as in "fusiform" aneurism. As the aneurism increases, however, the middle coat becomes more and more scanty in its walls, until it disappears, and after a time the internal coat ceases to expand, and then the sac is formed by the thickened adventitia only. In other cases the aneurism commences in an "atheromatous abscess" which bursts, or an "atheromatous ulcer." The part of the artery thus weakened yields and expands, but in this instance the intima, and most of the media, are absent from the sac, which resembles from the first the later stage of the previously described variety. As aneurisms grow, their wall is formed more and more of new fibrous tissue produced by inflammation of and around the sac, until at length none of the adventitia can be definitely detected. With yet further growth of the aneurism, the sac may be replaced in parts by surrounding tissues (muscles and bones) matted together, and even this may be over-passed, and a breach be made in it. Such aneurisms have usually a more or less globular form; they are also possessed of a sac or wall which is more or less distinct from the artery from which they spring, and they are known as globular, or sacculated aneurisms. In some cases, however, it happens that when an "atheromatous ulcer" forms, the arterial coats forming its floor and edge are not matted together, and the middle coat in particular is softened. The blood then finds its way in among the softened media, separating it into two layers, one adhering to the adventitia, and one to the intima; such an aneurism is called "dissecting."

CLASSIFICATION.

1. Fusiform aneurism
2. Sacculated aneurism { *a.* Circumscribed. *b.* Diffused.
3. Dissecting aneurism

A fusiform aneurism is one formed by the dilatation of the entire circumference of an artery, a dilatation both in length and breadth (Fig. 21).

A sacculated aneurism is the result of the dilatation of a part only of the circumference of an artery. So long as the tumour is closed in by a wall or sac it is called *circumscribed* (Fig. 20), but when the sac is incomplete, or the aneurism has ruptured, it is called *diffused.* Other terms in use are "*true*" and "*false.*" By a "*true aneurism*" is meant one the sac of which is formed by all three coats of the artery; a "*false aneurism*" is one in which the sac is formed by a part of the coats of the vessel only, by newly formed fibrous tissue, or by condensed surrounding structures. These terms should be discontinued, as the distinctions to which they refer are not clinically cognisable, and are of no therapeutic or pathological importance. The "*diffusion*" of an aneurism is better spoken of as its "*rupture,*" and should be regarded as a complication or accident in the course of an aneurism.

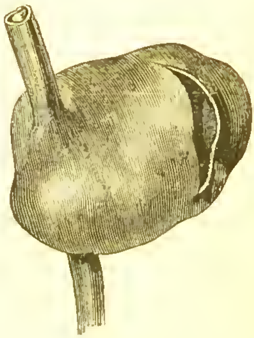

Fig. 20.—A large Sacculated Aneurism.

A dissecting aneurism is one in which the blood is contained in a space between the coats of the artery; this may become "diffuse."

Where two of these forms of aneurism coexist it should be called a "*mixed aneurism.*"

Fusiform Aneurism.

Fusiform aneurism is mostly met with in the arch of the aorta, but also occurs in any part of the aorta, innominate, carotid, or iliac arteries, and occasionally in the femoral and popliteal trunks. The shape and extent vary, and more than one such dilatation may be met with in the aorta. The sac is thicker than the healthy artery, and is formed by all three coats of the vessel; the inner surface of it is irregular, from atheroma; the adventitia is much thickened. The sac rarely contains any clot, and seldom undergoes spontaneous cure. The development and progress of this form of the disease are slow, and it may not give rise to any symptoms; on the other hand, it may cause death by pressure on important organs, such as the trachea and œsophagus. The bruit in fusiform aneurism is often very loud and rough. Occasionally a softened patch in its wall may entirely give way, and the aneurism

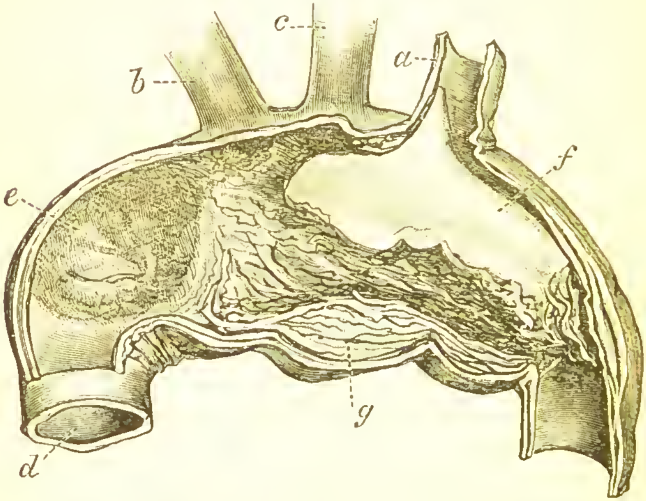

Fig. 21.—Fusiform Aneurism of Arch of Aorta; showing at *e*, a saccular pouch; *g*, laminated clot; *f*, recent clot extending into *a*, left subclavian artery; *c*, left carotid; *b*, innominate artery. (Mus. Roy. Coll. Surg., No. 3147.)

rupture; this is most liable to happen in the ascending aorta, the blood escaping into the pericardium.

Surgical treatment is not undertaken for this condition.

Sacculated Aneurism.

The sac.—The nature of the sac has already been pointed out; at first, when small, it may be simply a dilatation of a part of a vessel, but very quickly it is added to by new tissue and is the combined result of growth and stretching. The development of new tissue takes place chiefly in the outer coat. Aneurisms of large size are never "*true.*" "*True*" aneurisms are only met with in connection with large arteries; they are of small size, and being formed by the expansion of a large area of the vessel wall, have a wide communication with the artery; they can often be recognised by detecting atheromatous changes on the intima; in "*false*" aneurisms, where the intima and media are absent, atheromatous patches are never seen. In "*false*" aneurisms, the middle coat may be seen to terminate abruptly in a well-marked ring around the mouth of the tumour; the sac grows by fibrous tissue being formed on its outer surface, which more and more replaces the distended adventitia, until in large sacs there is little or none of the original vessel wall preserved. When the aneurism comes into contact with muscles, fasciæ, and bones, these are incorporated in the sac, being condensed and bound together by fibrous tissue.

Fig. 22.—Fusiform Aneurism of Popliteal Artery, entirely filled with Laminated Clot. Spontaneous cure. (Mus. Roy. Coll. of Surg., No. 3246.)

Contents.—A part at least of the contents of all uncured aneurisms consists of ordinary arterial blood, which is found, post-mortem, in the form of soft black clot. In most aneurisms a certain amount of clot is deposited during life, which is the resultant of two opposing forces, the tendency to coagulation on such an abnormal surface as the sac of an aneurism or a layer of fibrin, and the rapid movement of the blood; and as the one or the other preponderates differences are observed. The white corpuscles, however, have a tendency to adhere to the sac, inasmuch as it differs from normal intima; then they disintegrate and fibrin is deposited. Owing to the rapid motion of the blood, few, if any, red corpuscles are entangled in the clot, which is, as it were, whipped out from the blood; the centrifugal pressure keeps the clot closely in contact with the inner surface of the sac. The process may then be repeated; white corpuscles adhere to the fibrin, disintegrate and excite still further coagulation, and a second layer of clot lines the first; and so the clot may grow; successive layers forming from the sac towards the vessel. The fibrin is always deposited in layers, which are concentric, but no one of which will be found to line the whole of the sac. Such a clot is called *laminated fibrin, or clot*, and it is the *active clot* of Broca. Owing to variations in the shape of the sac, and in the position and size of its mouth, the condition of the blood in aneurisms varies in different cases; and when from any cause the flow of blood through the aneurism is slackened, red corpuscles become entangled in the meshes of the fibrin, and if the blood stagnates

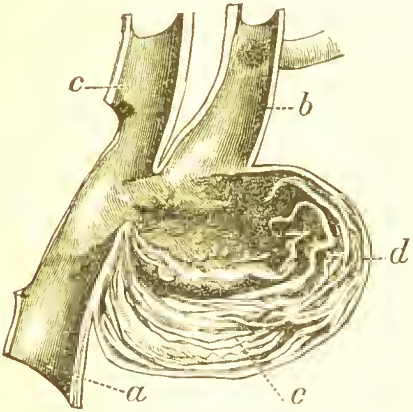

Fig. 23.—Sacculated Aneurism of Common Carotid Artery.

a, Common carotid artery; *b*, ext. carotid artery; *c*, int. carotid artery; *d*, sac of aneurism; *e*, laminated clot partly filling sac. (Mus. Roy. Coll. of Surg., No. 3221.)

a clot like that formed by shed blood is produced; this is known as the *passive clot* of Broca. All degrees between the two extremes may be met with, and they cause variations in colour and density of the clots. Fibrinous clots in aneurisms are not coated over with a layer of endothelium, as may occur in arteries or veins, and so they are ever-active causes of coagulation. These clots are extremely important, for three reasons: (1) by their gradual or rapid increase the aneurism may be permanently occluded; (2) they strengthen the sac and add greatly to the resistance it offers to the centrifugal force of the blood; (3) by partly filling up the aneurism they serve to lessen the pressure upon the sac, and therefore to diminish its rate of expansion; for by the law, illustrated by the hydrostatic bellows, every diminution in the cavity of an aneurism greatly lessens the total pressure of the fluid upon its walls. The changes in the clots are also important. Laminated fibrin is very stable; by constant pressure it becomes dry and firm, and the leucocytes within it, or between its layers, undergo fatty degeneration. When the aneurism is cured it may be slowly absorbed, but it forms by its density rather an impediment to organisation. When red corpuscles are enclosed they disintegrate and break down into dark granules. Soft or passive clot is, on the other hand, unstable; it may soften down, or it may "organise," or if compressed by the blood again entering the sac it may be flattened out into a thin layer, lining a fibrinous clot. (For further details as to these clots in blood-vessels *see* pages 421 and 422.)

Effects.—The effects of an aneurism are partly those caused by the development and growth of a tumour (pressure effects) and partly those due to interference with the arterial circulation.

1. *Pressure effects.*—The first and most constant result of the pressure of an aneurism is to excite

inflammation in the immediately adjacent tissues; this thickens the outer part of the sac, and mats the tissues together; when more severe it is attended with all the signs of acute inflammation, and ends in suppuration. The reason why the growth of an aneurism has this effect so much more constantly than any other tumour, is to be found in the fact that the expansile pressure of an aneurism, especially when large, is of far greater intensity than even that of the most rapidly growing solid tumour. The tissues and structures adjacent to aneurisms are compressed, matted together, blended with the sac, and then "ulcerated" or removed by interstitial absorption. From their proximity to arteries, veins are very often compressed, and more or less obstruction is offered to the venous circulation, leading to cyanosis and œdema of the part beyond, and dilatation of the smaller veins. A vein may ultimately be obliterated, or its wall ulcerated and a communication opened between it and the aneurism. (*See* Varicose aneurism, page 456.) Similarly an aortic aneurism may form a communication with the pulmonary artery. Nerves are stretched and flattened out, causing neuralgic pain, and spasms and paralysis of muscles. Bones are absorbed, being hollowed out or perforated, without any signs of inflammation in the bone around; this is most often seen in the sternum and spine. Cartilages, whether costal or intervertebral, have much greater power of resistance, and often are unaltered, when bone and fasciæ have disappeared. In certain situations special organs are compressed, as the œsophagus, thoracic duct, trachea, or a bronchus.

2. *Effects on the circulation*—(*a*) The force with which blood is propelled into an aneurismal sac is so much loss to the pressure with which the blood is propelled onwards, for only a trifling amount is returned in the form of elastic recoil; this *loss of force*

is the most constant and characteristic effect of an aneurism. As a direct result of it, we have the artery beyond less full of blood than it should be, and it therefore contracts, and the nourishment of the tissues supplied by it is *pro tanto* impaired. But nature, as it were, responds to the call of the impoverished tissues and partly filled arteries in two ways: (1) by hypertrophy of the left ventricle, and (2) by an enlargement of the collateral arteries above the aneurism, so that blood is poured into the vessels below partly by the main trunk and partly by the anastomosing vessels. When the condition of the patient is such that compensatory hypertrophy of the heart cannot take place, and the anastomosing vessels are so diseased that they cannot dilate sufficiently, the impairment of nutrition of the tissues beyond an aneurism becomes marked. In many cases the cardiac hypertrophy associated with aneurism is to a large extent due to the general loss of elasticity of the diseased arteries.

(*b*) *Interruption of the pulse wave* by the dilatation of the artery causes the pulse in the vessel beyond to be delayed in time and lessened in force. A sphygmographic tracing of the pulse in the artery below shows a loss of the impulse and dicrotic waves, and a diminution of the force and rapidity of the tidal wave (Fig. 24).

(*c*) *Obstruction to an artery* may occur in one of three ways: (1) the clot in the aneurism may extend into and block up the artery, or a portion of it may be broken off and carried into the artery as an embolus; (2) the mouth of a branch may be involved in the sac, and first stretched and then obliterated; (3) the sac of an aneurism may by its enlargement compress the vessel from which it springs. This occurrence is less well established than the two others.

(*d*) *Syncope* is a not infrequent effect of large aortic aneurisms; it may be caused (1) by the failure of the heart to overcome the great resistance offered by the blood in the enormously distended vessel, or (2) by the aneurism or a portion of clot obstructing the orifice of one or both coronary arteries, or (3) by the failure of the elastic recoil of the aorta to send blood into these vessels.

(*e*) *Gangrene* of parts beyond an aneurism may result from embolism, or from the more direct interference of the aneurism with the arterial supply to and the venous return from the tissues.

Course and terminations.—When the forces tending to enlarge an aneurism are exactly balanced by those tending to its cure it remains *stationary*, and this is occasionally observed even over a period of many years. More often this balance is not maintained, but the aneurism undergoes continuous enlargement or spontaneous cure.

1. *Spontaneous cure* may be brought about in one of three ways: (1) gradually by a filling up of the sac with *laminated clot;* the clot may then extend into the artery and occlude it (*see* page 418); this may happen (*a*) from the tendency to coagulation being in excess of the hindrances to it; it is favoured by an uniform and not too strong action of the heart, and by development of the collateral vessels; (*b*) from the sac of the aneurism compressing the artery above its mouth, and lessening the force with which blood is sent to it (?); (*c*) from the development of an aneurism higher up on the same trunk, leading to a lessening of the force with which blood is sent into the lower. (2) Suddenly by *embolism.* A portion of clot from the aneurism, or from one higher up on the same trunk, may be washed into the artery below and plug it; by the diversion of the circulation the blood pressure is so lessened in the aneurism that coagulation occurs. (*See* also page 421.) Or a portion of clot may lodge in the

mouth of the aneurism and shut it off from the artery; the blood in the sac then coagulates. (3) *Plastic arteritis* may be excited by inflammation around the sac and seal the artery both above and below the tumour; this is a rare event. (*See* also Suppuration, page 424.)

2. **Spontaneous enlargement.**—The continuous growth of an aneurism may be fatal from its pressure effects or from syncope, as is often seen in thoracic aneurism; but if not it ends either in *rupture* or in *suppuration,* and these may be called its natural lethal terminations.

(1) *Rupture* results either from the aneurism extending through the skin or into some cavity of the body, or from the blood forcing its way through the sac into the surrounding tissues. If it burst externally, or into a serous or mucous cavity, fatal hæmorrhage occurs, unless by some chance, as in the case of Liston, the orifice be effectually plugged with a clot; into a joint the hæmorrhage is less extensive. The aperture through a serous or synovial membrane is a slit or stellate opening, and the hæmorrhage through it is sudden and profuse; the aperture through a mucous surface is smaller, and often becomes blocked temporarily with clot, so that the hæmorrhage is at first slight, is repeated, and is finally profuse; the aperture through skin is formed by the separation of a slough of corium, and the hæmorrhage is at once fatal unless controlled by surgical means. When the blood is extravasated into the tissues one of two results may follow: it may diffuse itself widely along the cellular tissue of the part, or after a certain amount has escaped from the sac it may coagulate, and the clot thus formed, together with fasciæ and the products of the inflammation excited by the extravasated blood, may form another sac; in such a case, this secondary sac

usually quickly yields again; these facts explain the variations met with in cases of *diffused aneurism.*

(2) *Suppuration.*—The inflammation excited by an aneurism may become acute and end in suppuration of the tissues adjacent to the sac; this is most often seen where, as in the axilla, the aneurism is surrounded by loose cellular tissue, and where a slow rupture of the sac has occurred. The pus thus formed tends to reach the surface, and to burst externally like that of any acute abscess. Two special effects of the suppuration, however, must be noticed: (*a*) the sac is deprived of all nourishment conveyed to it by the vessels on its exterior; it therefore sloughs; this sloughing is the effect and not the cause of the surrounding suppuration; (*b*) the inflammation extends along the sac to the artery and excites arteritis; if this assumes the plastic form it seals the vessel, and when the sac separates the aneurism is quite cured; but if it is suppurative such a closure of the vessel does not occur, and either before or after the abscess around the aneurism has burst the artery opens into it and then fatal hæmorrhage occurs. This latter is the more frequent event of the two.

Signs and diagnosis.—I will first describe the common sacculated aneurism, and then the changes produced by cure, by subcutaneous rupture or "diffusion," and by suppuration.

A. **Signs and diagnosis of an ordinary sacculated aneurism.**—The primary phenomenon is the presence of a *tumour* over and fixed to an artery; it may vary in shape, but is usually more or less globular; in size it ranges between that of a small nut and a cocoa-nut. If placed deeply or containing much clot it is firm, but if superficial, or containing little clot, it is softer, and may even fluctuate. This tumour *pulsates*, being expanded and rendered more tense with each beat of the heart. The force of the pulsation depends partly upon that of the cardiac contraction, but more upon the proximity of the aneurism to the heart, the size of the sac, and the amount of clot which lines it. It may be more marked in some situations than others, owing to irregularity in the thickness of the clot, but so long as the aneurism has a cavity into which blood is forced with each systole, the pulsation is of an *expansile character.* If the limb is depressed, the force of the pulsation and the tension of the aneurism may be noticed to be

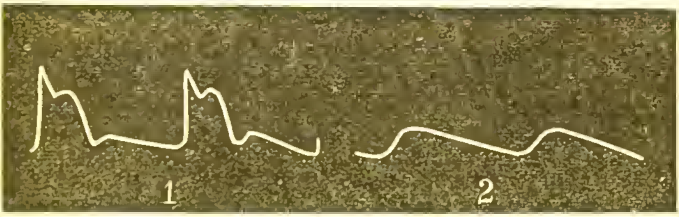

Fig. 24.—Sphygmographic Tracings of the Radial pulse of a patient with Aneurism of the Right Brachial Artery.

1, Left radial pulse; 2, right radial pulse. (Mahomed.)

increased, while if it is raised both are diminished; this is owing to the expansion and contraction of arteries which takes place in dependent and raised limbs. If the main artery of the part is compressed above the aneurism, so as to arrest the arterial flow, the pulsation in the aneurism ceases, and the tumour shrinks and becomes less tense: by gentle pressure the surgeon may then be able to empty the sac still more; if now the finger is raised from the main artery the tumour rapidly fills out again, and in two or three beats resumes its former size and tension. This shrinking of the tumour when the circulation is arrested is due to the elastic recoil of the stretched sac and adjacent tissues, and the degree to which the tumour can be emptied is a measure of the amount of fluid blood it contains. Compression of an artery just beyond an aneurism is said to cause the tumour to become more tense. In nearly all cases of aneurism a *bruit* is heard on listening over the tumour; it varies much in different cases, but is most often systolic in time and blowing in character; it is heard equally well all over the tumour, and is not increased by moderate pressure; occasionally it is diastolic as well as systolic. The bruit is due to vibrations caused by the blood rushing into or out of the aneurism, and churning in the sac; it varies, therefore, with the position, size, and shape of the mouth, and the disposition of the sac and clot within it. The rush of blood into the aneurism may also cause a *thrill* in the sac with each heart-beat; such a thrill is only felt over the tumour. The *pulse* in the artery below, when compared with that on the opposite side of the body, is delayed in time, and usually lessened in force; sometimes it is absent owing to obliteration of the artery. The sphygmogram is characteristic (Fig. 24).

The *veins* below the aneurism may be distended and varicose, and the subcutaneous tissue œdematous, owing to venous obstruction. *Muscular weakness* and *wasting* are frequently noticed, owing to defective nutrition and to paralysis of the stretched nerves; similarly areas of the skin may be found *numb*. The *pain* of aneurism may be very severe, or only slight; it is of two kinds, a constant deep boring, aching, or burning pain, caused by the peri-aneurismal inflammation, the tension of the parts, and especially by the absorption of bone, and a sharp lancinating pain, shooting down along the branches of compressed nerves. *Muscular spasm* and *paralysis* are due to irritation and destruction of motor nerves, and the most familiar instance of each is the dilatation of the pupil or paralysis of the vocal chord, from pressure upon the cervical sympathetic or the recurrent laryngeal nerve. The *heart* is usually hypertrophied, and the *arteries* are often found to be atheromatous. There is no means of distinguishing a "*true*" from a "*false*" aneurism without careful dissection.

B. **Signs and diagnosis of a cured aneurism.**—When an aneurism is undergoing the process of gradual occlusion with laminated clot, the tumour becomes smaller and harder, with less pulsation, its compressibility when the circulation is arrested diminishes, and the bruit and thrill are modified or lost. When the aneurism is completely occluded, but the artery on which it lies is still patent, the tumour has a heaving pulsation, is quite incompressible, and if a bruit be heard over it, it is increased in intensity by gentle pressure. The fixity of such a tumour to the artery, and its previous condition when known, serve to distinguish it from a gland or other solid tumour over an artery. When the artery also is occluded, as usually happens, pulsation disappears, and the collaterals may be felt to be enlarged. When the cure takes place more rapidly it is often marked by a sudden pain in the part, a sudden failure in the circulation beyond, with abrupt cessation of the pulsation, bruit, and thrill in the tumour; this then quickly consolidates and gradually shrinks, while meanwhile the anastomotic vessels may be felt to enlarge, and the circulation beyond is restored.

C. **Signs and diagnosis of diffused aneurism.** — When subcutaneous rupture of an aneurism occurs, and the blood is freely extravasated in the cellular tissue, sudden pain which may be very intense is experienced, and the patient becomes cold, pale, and faint; the parts about the aneurism become very greatly swelled, livid, and cold; the pulse is arrested in the arteries beyond, and these parts become œdematous, livid, and then gangrenous, from the effused blood entirely obstructing the venous circulation. In the more common cases, in which the rupture is less extensive, and the blood is, at any rate for a time, surrounded by dense tissues and blood clot, the patient experiences a sharp pain in the part, and becomes pallid and faint; the aneurismal tumour is found to have suddenly increased in size, but to have lost its distinct outline, the pulsation is lessened or lost, and the bruit and thrill are altered in character, diminished, or entirely lost. The coagulation of the effused blood makes the tumour harder than it was before. Such an aneurism extends rapidly, and when it reaches the skin it points, and often fluctuates before bursting, just like an abscess. The circulation in the parts below is more or less interfered with; the pulse in the arteries is usually still more weakened, and may be lost; the veins are distended, and the tissues œdematous; the pressure on the nerves makes the parts affected numb, heavy, and motionless. There are still other cases in which the "diffusion" is much slower, and that may be called "*leaking aneurisms.*" They are characterised by continuous growth of the aneurism, together with diminished pulsation, indistinctness of outline, and an increase in the pressure signs. Such a tumour may at any time become more completely "diffused." These three varieties might be distinguished as "ruptured," "diffused," and "leaking" aneurisms.

D. **Signs and diagnosis of suppuration of an aneurism.**—Suppuration around an aneurism causes an increase in the swelling which obscures the outline of the tumour, the part is hot, red, painful and tender, and pits readily on pressure, and there are also a high temperature and the other phenomena of marked pyrexia. When pus forms the swelling fluctuates and "points," and when it is evacuated, chocolate-coloured pus, mixed with fibrinous coagula, are discharged, and subsequently free arterial hæmorrhage may occur. If, before the abscess bursts, the artery opens into it, there will be a sudden increase of the swelling, with great increase in the force and superficiality of the pulsations. The signs of "*suppuration*" and "*diffusion*" are closely alike; both are attended with increased swelling, diminished clearness of outline of the tumour, and lessened pulsation. In "*diffusion*" the part is cold, and there is no fever; in "*suppuration*" there is fever, and the part is hot, while the circulation in the arteries beyond may be but little interfered with.

Treatment.

In treating an aneurism the surgeon endeavours, as far as possible, to imitate the natural cure of the disease, and to bring about the occlusion of the sac, with or without the adjoining portion of the artery, by blood clot. There are three known ways of doing this: (1) *by lessening the force of the circulation through the aneurism;* (2) *by increasing the coagulability of the blood;* (3) and by *directly causing the blood in the sac to coagulate.* In the large majority of cases the natural tendency to coagulation in an aneurism exerts itself as soon as the special hindrance to it (the rapid and forcible circulation) is removed. Coagulation can only be *excited* in an aneurism by local means; but direct interference with an aneurism is always dangerous, and is never to be resorted to when other measures succeed. On the other hand, the plasticity of the blood can only be increased by constitutional treatment, while the force of the circulation in an aneurism can be lessened by either constitutional or local means. It follows from this that the treatment of every case of aneurism must be first *constitutional*, and then *local*, for local measures are only resorted to as adjuvants of general measures, where the aneurism is so placed as to permit of it; in some cases constitutional treatment alone succeeds, and in many it is the only course open to the surgeon to adopt. Still more to emphasise the importance of the constitutional treatment of aneurism, and the necessity for carrying it out with scrupulous attention to all details, even where the local treatment of the disease is difficult and prolonged, I shall describe it first, and then deal with the varieties of local treatment, and I shall endeavour to view each in relation to the three possible factors in the artificial obliteration of an aneurism.

Constitutional Treatment.

A. The first thing to aim at is to *reduce the arterial tension to a minimum, by lessening the force of the heart,* and by *diminishing the total quantity of the blood.*

1. *To lessen the force of the heart* the patient should be placed in the horizontal position, unless this be specially contra-indicated, and everything be done to ensure his keeping at *perfect rest;* he should not be allowed to move, all his wants must be attended to by others, and he must be guarded against every source of mental and emotional excitement. In cases where the heart's action is unduly excited some benefit may be obtained by aconite or belladonna internally, or by wearing a belladonna plaister over the præcordia. Opium may be of considerable service in allaying physical and mental restlessness.

2. *To reduce the quantity of the blood* it is generally sufficient to place the patient on a very *restricted diet,* such as the following: 6 oz. of bread, 2 oz. of meat, a little butter, and 6 oz. of milk or water, *per diem.* When the patient is plethoric and the arterial tension very high, *repeated saline purges*

or *venæsection* may be resorted to. If a patient is already anæmic when he comes under treatment, of course no further reduction of the blood volume is required.

B. *To increase the plasticity of the blood* is the second aim of constitutional treatment, but so little is definitely known of hæmapoiesis and the means of influencing it, that this branch of the subject is involved in uncertainty. It is believed that such a dry restricted diet as mentioned above increases the proportion of fibrin in the blood; with the same view, iron and a richly nitrogenous fare have been prescribed to anæmic patients. Iodide of potassium in full physiological doses has been much recommended; perhaps the relation of syphilis to aneurism has created some prejudice in its favour; its value is questionable. Acetate of lead has also been given to quiet the circulation and to modify the blood's composition, but its efficacy has not been demonstrated. The increase in the quantity of fibrin in blood must be distinguished from the readiness with which it coagulates.

Local Treatment.

The simplest of all local treatments is to raise the part, if a limb, and to bandage it, applying gentle pressure over the tumour. By these means the arteries of the part are made to contract, the supply of blood to the aneurism is lessened, the sac is supported, and the contractility of it and the surrounding tissues is favoured. Unless there are special conditions of urgency, these local means, together with careful constitutional treatment, should in all cases be patiently tried before any more active measures are resorted to. The other local measures will be grouped into those modifying the circulation in the aneurism, and those exciting the coagulation of the blood.

A. **To modify the circulation in the aneurism** two procedures are adopted, the ligature and compression, each of which is susceptible of various modifications. The ligature, as the older method, will be considered first.

THE LIGATURE.

1. Double ligature.	
2. Proximal ligature	*a.* Anel's method. *b.* Hunter's method.
3. Distal ligature	*c.* Brasdor's method. *d.* Wardrop's method.

This classification of the varieties of ligature is not only convenient, but expresses the order in which each method was introduced.

1. **The double ligature** is often known as the "old" operation for aneurism, or the operation of Antyllus. It consists in making a free incision into the sac, turning out all the coagula, introducing a probe into each end of the artery, and then cleaning and tying it, as well as any other branches opening out of the sac. Even when the part is previously rendered bloodless, the operation is one of extreme difficulty, and, before the introduction of the bloodless method, was so formidable that surgeons could rarely be prevailed upon to undertake it. The first danger of such an operation is *primary hæmorrhage.* If that is obviated, the vessel is tied in a part of its course where it is certainly diseased, and where there is a serious risk of *secondary hæmorrhage.* Should the extensive wound suppurate, and this used to be invariable, *gangrene* is liable to ensue upon the obstruction to the venous return and the development of the anastomotic circulation thus produced. Owing also to the great success of other treatment,

this operation is now only very rarely undertaken for spontaneous aneurism.

2. (*a*) **Anel's operation** is to apply a ligature to the affected artery close above the aneurism, but without interfering with the sac itself. It has the serious disadvantage of operating upon a part of the vessel which is almost certainly diseased, and, in addition, the proximity of the wound to the aneurism

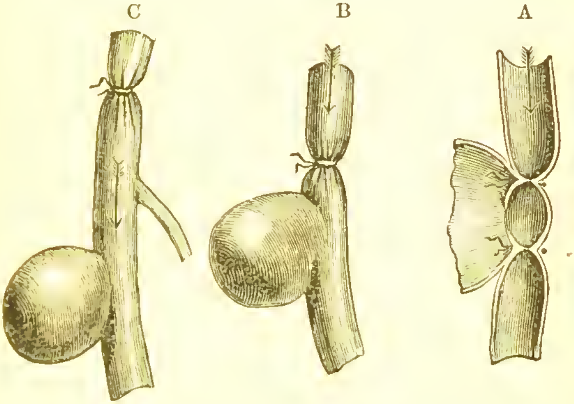

Fig. 25.—Diagrams illustrating Ligature of Arteries for Aneurism.
a, Old operation ; *b*, Anel's operation ; *c*, Hunter's operation.

is liable to excite inflammation in and around the sac. This operation is only done where the Hunterian operation is impracticable.

2. (*b*) **Hunter's operation** consists in ligaturing the affected artery at some distance on the cardiac side of the aneurism. It has two main advantages, in that the part of the artery tied is probably healthy or less diseased than close to the aneurism, and the sac is not directly interfered with. Very often branches arise from the artery between the ligature and the sac. This operation has been by far the most successful of

any proposed for aneurism, and its details must be fully considered.

Effects.—The immediate effect of tightening the ligature is to occlude the artery, and to shut off the force of the heart from the aneurism. (For the effects of the ligature on the vessel itself *see* page 370, and for the results and treatment of arterial occlusion *see* page 386.) The blood in the aneurism may now at once coagulate. More often, however, when the anastomotic circulation is established, blood again flows through the artery and the aneurism, but either in a continuous current or with gentle pulsation only, and, under this influence, more and more coagulum is deposited within the tumour until it is quite filled, and then, as a rule, the clot projects into the artery and grows until it has obstructed it as far as the next branches above and below. When this is the case the aneurism gradually shrinks and is absorbed; and the artery is converted into a fibrous cord as if it had been ligatured. This second obstruction in the artery sometimes necessitates the development of a second series of anastomosing vessels from the artery between the two obstructions to the vessels beyond the aneurism. When the ligature is so placed that no large branch intervenes between it and the aneurism, the clot is continuous from one to the other, and only a single set of anastomosing vessels enlarge.

Symptoms.—At the moment of tightening the ligature the aneurism ceases to pulsate and shrinks; it may then quickly become firmer, and no change beyond that and its general shrinkage may be observed, until it disappears altogether. Very often, in eighteen to thirty hours, when the anastomosing vessels are fully dilated, and the limb is warm, a faint pulsation or a trembling sensation is detected in the tumour, which may last for hours or days, and then pass off, or become permanent. At a later period also temporary pulsation may be observed. If the aneurism is occluded, and the artery patent, a heaving impulse is conveyed to it from the vessel.

Dangers. — The first danger attending this operation is *secondary hæmorrhage* at the seat of ligature; for the causes, mode of prevention, and treatment of this accident *see* page 376. The next danger is *gangrene.* We have already seen that an aneurism impedes the circulation in a limb or other part, and when to this impediment that of ligature of the main artery is added, and to that occlusion of the vessel at the seat of the aneurism, it is easy to understand how this danger arises. The gangrene is generally of the "moist" variety, for venous obstruction is a marked element in the case. A less common accident is *inflammation* and *suppuration* around the sac; this most often occurs in the axilla and groin, where aneurisms are not well supported, and in cases of very large sacs, or where the aneurism is becoming diffused. The causes that have been assigned are the handling to which the tumour is subjected before and after treatment, and the presence of large masses of fibrin in the sac.

Failure to cure the aneurism results, in a certain number of cases, from the anastomotic circulation being too free. This recurrent pulsation may come on about a day after the operation and persist, or about a month later, when the anastomotic circulation is thoroughly established. Occasionally a second aneurism develops in the site of one that has been cured, not from yielding of the aneurismal cicatrix, but from a second aneurism springing from the artery close to the original tumour. Another accident that sometimes happens is for the tumour to enlarge without any pulsation, the blood welling into the sac from the distal side, but flowing in without any pulsation.

Treatment.—Immediately after ligature, the limb, covered up with a thick layer of cotton wool, should be slightly raised and supported evenly on pillows. Should pulsation recur the surgeon must have patience, as it will probably pass off; but if after some months the expansile pulsation continues, compression of the main artery should be tried, combined with pressure upon the tumour, or, if the aneurism is in the ham, flexion is likely to succeed. If these means fail, the artery should, when practicable, be ligatured at a higher spot than before; but when this is impossible, as in carotid and axillary aneurisms, the sac must be laid open, and all the vessels opening into it tied. If after ligature the part beyond the aneurism swells, remains cold, and becomes livid, gangrene is threatened; should the aneurism be a large one, or diffused, the obstruction may be sufficiently relieved by laying open the tumour, removing the clots, and tying any bleeding vessels. If gangrene has set in there is no remedy but amputation above the aneurism. Where the sac suppurates the same alternative is present, *i.e.* the "old" operation or amputation; the danger of the former is hæmorrhage. Where hæmorrhage has already occurred it is certainly safer to amputate at once; but when suppuration is only threatening an antiseptic incision might succeed in cutting short the inflammation; until the wound heals a tourniquet should be kept on the main artery ready to be screwed down at the first appearance of bleeding. A singular accident has been known to occur when catgut is used for the ligature: the gut has softened too soon, and the channel of the vessel has been at once restored; in such a case the operation must be repeated, the second ligature being tied close above the first.

3. (*c*) **Brasdor's distal ligature** consists in tying the diseased artery beyond the aneurism, as, for

instance, where the upper end of the carotid artery is ligatured for an aneurism close to its origin. It resembles in its mode of action the plugging of an artery by an embolus washed out of an aneurism, and it depends for its success upon the diversion of the stream of blood into a collateral artery or arteries coming off on the cardiac side of the aneurism. Thus, in the case mentioned, the diversion of the blood into the subclavian artery so diminishes the pressure in the carotid artery that the vessel shrinks, and clotting occurs in the aneurism; coagulation may also extend directly from the ligature back to the aneurism.

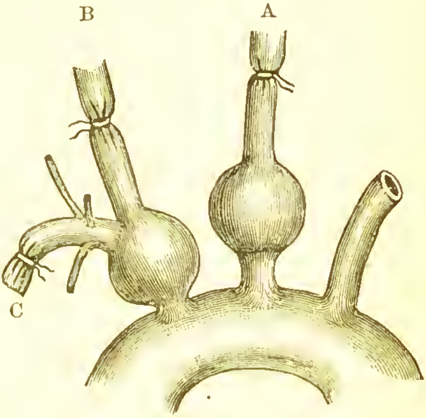

Fig. 26.—Diagram illustrating the mode of applying Distal Ligature for Aneurisms at the root of the Neck.

The ligature on left common carotid artery A is Brasdor's operation; ligature of right carotid and subclavian arteries B and C for innominate aneurism is Wardrop's operation.

3. (*d*) **Wardrop's operation** is a modification of Brasdor's, in which one or more of the branches coming off beyond the aneurism are tied. In mode of action it is like Brasdor's, but, inasmuch as the diversion of the blood stream is less complete, and a current is still permitted to flow through the artery, its effects are less good. The distal ligature is only used where it is impossible to employ the proximal, and even in these cases the success attending it has not been great. In some cases, after a temporary improvement, the sac has rapidly enlarged, or has become inflamed and suppurated.

COMPRESSION.

1. Digital compression.
2. Instrumental compression.
3. Flexion.
4. Esmarch's bandage.

Compression aims at curing an aneurism by the temporary interruption of the blood current through the main artery; with this exception, the principle of its action is closely like that of the ligature, and its varieties may be classified precisely like those of the ligature; for Reid's treatment and flexion resemble the double ligature, and simple compression of the artery may be proximal or distal.

1. **Digital compression** is placed first in the table because it is the best means yet adopted for controlling the flow of blood through an artery. It is necessary that the vessel be not too deeply placed and be well supported by bone, so that the pressure of the thumb can readily control the circulation through it. Sufficient force is used just to stop all pulsation in the aneurism, but it is not necessary completely to occlude the artery, and still less is it right to use such force as to light up arteritis. The hand quickly wearies unless the muscles be relieved by resting upon the thumb a weight of about six to eight pounds; pressure can then be maintained for about half-an-hour; the need for relays of assistants to keep up the compression is the chief drawback to this treatment. Three men should be in attendance together, one compressing the artery, one with his hand on the aneurism to regulate the amount of compression, and the third resting and ready to relieve the compressor when tired. When the change is made care must be taken to have the artery controlled by the second man before the first removes his thumb. Attention to this not only protects the aneurism from a sudden return of pulsation

in it, but it provides for a slight alteration in the part of the vessel compressed. The merits of digital pressure are, that it is *less painful* than instrumental, and, at the same time, it is *more exact*, for the pressure can, in many cases, be brought to bear upon the artery alone without involving the companion vein and nerves; the force required can be *better regulated*; the thumb is also less liable to cause *galling of the skin* than any other compressor, and it can be applied to *certain situations* where instrumental compression cannot, *e.g.* the common carotid artery.

2. **Instrumental compression** is carried out by various forms of tourniquets and compressors which replace the thumb more or less efficiently. The best are Carte's, in which the compressing force is elastic, and a simple weight. In using any form of instrumental compression three objects must be kept steadily in view: (1) So to adjust the instrument as to compress the artery only, and with not too much force; (2) to exert the pressure on two parts of the vessel alternately, using two instruments, one of which is adjusted before the other is raised; and (3) to prevent galling of the skin by shaving the part and applying French chalk, fuller's earth, or violet powder. Instrumental compression can be carried out by an intelligent nurse, or in some cases by the patient himself, and it can be applied to the abdominal arteries, where the pressure of the thumb is of no avail.

The **effects of compression** vary in different cases. When the blood still flows through the aneurism in a pulseless stream, the fibrin is whipped out of it, and is gradually deposited, layer by layer, slowly obliterating the tumour; but when the compression causes the blood to stagnate in the aneurism it may clot *en masse*, and quickly or suddenly occlude it. Between these extremes there are all grades of rapidity of cure, and of the extent to which the clot formed contains red corpuscles.

The difference between fibrin and blood clot is very important; while fibrin forms slowly, it is very persistent, and the cure thus brought about is permanent; on the other hand, blood clot quickly consolidates an aneurism, but is less resistant, being easily disintegrated by the force of the uncontrolled circulation, and, therefore, unless protected until it has consolidated and organisation has commenced in it, the clot is apt to disappear. The rapidity with which the sac becomes pulseless and unyielding is the guide to the kind of clot that has filled it. As in all other modes of cure, obliteration of the aneurism is in nearly all cases attended with occlusion of the adjoining portion of artery. When long continued, compression leads to enlargement of the collateral arteries, and also to adhesion of the artery to the vein and its sheath.

The *mode* of practising compression may be varied considerably. Wherever possible it should be proximal rather than distal; the disadvantages of the latter being the same as of distal ligature. It may be continuous or interrupted; the former being by far the better where the patient can bear it, and arrangements for carrying it out can be made. Or digital compression may alternate with the use of a compressor, or the amount of compression may be diminished to allow the patient to sleep. Opium is often of use to keep the patient quiet, to dull his sensibilities, and to procure sleep; and when considerable pressure has to be used, especially for controlling the abdominal arteries, the patient may be kept under the influence of anæsthetics while the compression is applied.

The arrest of pulsation, and the consolidation of the tumour, are the signs that the treatment has succeeded. When this is noticed the compression is to be moderated, but still continued for about forty-eight hours. To discontinue it at once imperils the softer clot, and may entail failure.

Where compression fails, ligature may often be successfully practised, but it influences the result of the operation in several ways. A ligature should never, if possible, be placed exactly where an artery has been subjected to long compression, on account of the matting together of the parts increasing the danger of injuring or occluding the vein. The enlargement of the collaterals diminishes the risk of gangrene after ligature, but, at the same time, it lessens the prospect of cure, owing to the freedom with which blood at once enters the sac.

3. **Flexion.**—Aneurisms in the ham or at the bend of the elbow can often be rapidly cured by fully flexing the joint for several hours. By this means the sac of the aneurism is compressed, and the artery itself is occluded, partly by pressure, partly by the bend in its course. In this way the blood in the sac is left stagnant, and it may coagulate *en masse*. If the flexion is less acute, the flow of blood through the aneurism is only moderated, and then the sac may be more gradually filled with laminated fibrin. The limb should first of all be evenly bandaged from the fingers or toes as high as the joint; it should then be fully flexed and fixed by a bandage, a strap and buckle, or heavy sand-bags. Every twelve hours the flexion may be carefully lessened, so as to allow the surgeon to examine the part, and, as soon as the sac is found to be consolidated, it is to be protected from the full force of the blood, either by moderate flexion or some form of compression of the artery above. This treatment has the merits of simplicity, safety, and rapidity, and it is attended with a minimum of discomfort. It is especially adapted to

small slowly-growing aneurisms, and should never be employed when the tumour is of large size, rapidly growing, or threatening to become diffused.

4. **Esmarch's bandage** (Reid's treatment) has been used to secure stasis of the blood in an aneurism and its coagulation *en masse.* The elastic bandage is usually applied firmly from the fingers or the toes up to the tumour; it should then be carried lightly over the aneurism so as slightly to compress the sac, and perhaps also empty the companion vein, and then continued firmly for a short distance higher. It is better to leave the bandage on than to encircle the limb above it with the elastic cord and remove the bandage. The bandage should be left on for an hour and a half, and, before its removal, the main artery above should be compressed by the finger or tourniquet for twelve to forty-eight hours, to moderate the force of the blood in the artery. When successful, the stagnant blood coagulates in the aneurism under the influence of the sac or the fibrin lining it, and the clot extends into the adjoining portion of the artery. Here, if protected from the full force of the heart, it readily organises and obliterates the vessel. In the aneurism the clot may be absorbed, or may organise, or may long remain as a dry, friable mass, these results depending upon the nature of the strueture immediately surrounding it. This treatment may fail either because the blood does not coagulate at all, because the clot does not extend into the artery, or because the clot is disintegrated under the full force of the circulation. The advantages of the method are its simplicity and rapidity. Its disadvantages are, that it is so painful as usually to require anæsthesia during the application of the bandage; that it may modify the general blood pressure to a serious extent; that by causing rupture or thrombosis of the arteries around the sac, it may interfere with the anastomotic circulation and cause gangrene, and

that it may rupture the sac. In many cases it has failed to cure, but it has not in any way lessened the prospect of success by the ligature.

Two other modes of applying compression require a brief notice. *Acupressure* by means of a long, stout, curved needle, passed well beneath both artery and vein, and a pad fastened over the artery by a thread tied around the ends of the needle, has been suggested, but the plan has nothing whatever to recommend it. Dr. Dix has practised *compression by a wire* passed beneath the artery as for its ligature; the ends of the wire are then passed out through the skin on one side of the wound, and about an inch apart; a piece of cork is laid over the artery, and the ends of the wire are twisted over it sufficiently tight to impede, but not to arrest, the flow of blood through it. If this degree of compression be insufficient, the wire can be tightened by inserting small plugs of wood beneath it. When the aneurism is consolidated the wire is untwisted, the ends straightened out, one of them cut short, and the remainder withdrawn. The advantages of the plan are that the wire can be placed anywhere in the course of the artery, that it does not obliterate the artery, and that the pressure on the vessel can be easily regulated; the disadvantages include those common to all cutting operations which expose large arteries.

B. **To excite immediate coagulation in the aneurism.**—The means used for this purpose are: *manipulation, introduction of foreign bodies, injections of coagulants, and galvano-puncture.*

(*a*) *Manipulation* was suggested by Sir Wm. Fergusson. His object was to displace the clot lining the sac into the mouth of the artery. The artery is compressed on the cardiac side, and then the sac is inverted by the thumbs until its contents are felt to be displaced. The method is very dangerous in aneurisms at the root of the neck, as fatal or serious embolism may occur; it is likely also to lead to rupture of the sac or to suppuration around it. Much gentler manipulation, with the view of disarranging the laminated fibrin in a sac, and so of leading to more rapid coagulation, may be employed in conjunction with the ligature or compression, for aneurisms of the extremities.

(*b*) *Foreign bodies* such as iron wire, catgut, or horse-hair, have been introduced into the sac of an aneurism. The best material to employ is fine steel wire coiled small, and rendered aseptic by prolonged immersion in liquor potassæ, and then passed into the sac through a Southey's canula. This treatment is not generally viewed with favour, but one successful case and one other very encouraging one have recently occurred. *Acupuncture* needles passed into an aneurism and allowed to remain for a few days have succeeded in setting up coagulation in otherwise intractable cases.

(*c*) *Injection of coagulants*, such as perchloride of iron, has been practised. It should never be undertaken unless the artery above and below is compressed during, and for some time after, the injection. Langenbeck has suggested the injection of a solution of ergotin around the sac with a view to excite contraction of the muscular fibres in its wall, but at present this treatment lacks both theoretical and practical sanction.

(*d*) *Galvano-puncture* is employed as follows: Two fine steel needles, carefully insulated to within one-third of an inch of their points, are introduced into the aneurism about one inch apart, having the whole of their bare points within the sac. They are then connected with the two poles of a constant current battery, and the current of ten to twelve Leclanché cells is passed through them until some decided effect (hardening or diminished pulsation) is produced; the needles are then withdrawn, and the punctures sealed with collodion. When successful a firm clot is formed around the positive pole, consisting of fibrin, and coagulated albumen precipitated by the dissolved iron of the needle. Around the negative a soft, frothy clot is formed. The evolution of gas has been known to be so abundant as to render the percussion note resonant. The operation requires repetition. The current should be of low intensity, but of high tension, such as is obtained from several small cells.

These methods of inducing coagulation by direct excitement are rarely, if ever, used in any but internal aneurisms, inaccessible to treatment by other surgical means. They are all dangerous from embolism and suppuration, and they often fail to cure. Galvano-puncture has, at present, had the greatest amount of success; acupuncture has proved useful, and has the merits of simplicity and comparative safety; manipulation and injection should be entirely abandoned; the improved method of introducing steel wire has been insufficiently tested; I recently saw it practised, and practised it myself in a case with imperfect, but yet very encouraging, success.

An Estimate of the Comparative Value of the Methods of Treatment.

The old operation of the double ligature is rarely to be resorted to; it may be employed in embolic aneurism of the upper limb in young people, where the artery is healthy except just at the site of the aneurism, in cases of recurrent pulsation, especially in aneurisms of the upper limb, and when, after ligature of the artery, the sac inflames and suppurates.

Direct coagulants are to be employed in *external aneurisms* only when other means have failed, and in conjunction with them; these cases are very rare.

Compression and ligature.—Wherever the surgeon has a choice, the proximal ligature or compression is to be preferred to the distal, and the pressure or ligature should be applied at some distance from the tumour. It will be well to compare the treatment by compression and the Hunterian ligature from several different points of view.

(*a*) *Effects on the artery.*—The ligature causes the permanent obliteration of the artery where it is tied, and the enlargement of anastomosing vessels above and below; it interrupts the direct and forcible flow of blood into the aneurism; it is attended with the danger of secondary hæmorrhage, especially in the upper limb. Compression entails only a temporary obstruction of the artery, and it may be partial or complete, continuous, remittent or intermittent, at the will of the surgeon. There is no danger of secondary hæmorrhage.

(*b*) *Effects on the aneurism.*—These may or may not be precisely the same in the two cases. The ligature may so arrest the circulation as to cause clotting of the entire quantity of blood in the aneurism, or the anastomotic circulation may be so free as to lead the blood to deposit layer upon layer of fibrin, as it tardily flows through the sac. The effects of compression depend not only upon the freedom of the anastomotic circulation, but also upon the completeness and persistency with which the flow through the artery is arrested.

(*c*) *Effects on the local circulation.*—The ligature usually entails the development of two sets of anastomosing vessels, *i.e.* around the ligature, and around the aneurism. Compression entails the development of one set of anastomosing channels only, that around the aneurism; and during the time that these vessels are called upon to carry on the circulation, the pressure upon the artery is relaxed or discontinued. Hence compression puts less strain upon the local circulation than the ligature, and does not expose the patient to the same risk of gangrene.

(*d*) *Effects on the general circulation.*—Compression, when not entirely obstructing the artery, or not continuous, does not tend to increase the general arterial tension, as the ligature may.

It is evident, therefore, that compression and ligature bring about the cure of aneurism in precisely the same way, and, roughly speaking, their effects are the same; but not only is compression free from all danger of hæmorrhage and of gangrene, but it affords the surgeon the opportunity of regulating the effect upon the local or general circulation, in a way that is impossible when an artery is tied.

(*e*) *Safety.*—The introduction of aseptic ligatures which do not sever the vessel has reduced the danger of ligature very considerably. Could a fair comparison of statistics be made, it is probable that it would appear that the operation of ligature conducted with all proper precautions is only a little more dangerous than compression, the difference depending upon its greater liability to cause gangrene, and its more marked effect upon the general circulation.

(*f*) *Convenience.*—If my last statement is correct, the question of convenience of one or other method becomes important; here the balance is decidedly in favour of the ligature. Anæsthesia renders the operation of ligature painless, but there are undoubted disadvantages in keeping a patient under the influence of ether, or in a stupor from morphia, for the many hours or longer that it may be necessary to employ compression.

(*g*) *Applicability.* — Compression of abdominal arteries is both difficult and dangerous, and in this situation the ligature is to be preferred, except in the case of the aorta. Where there is an internal aneurism present as well as an external, or the heart is incompetent from disease, the grave and continuous effects of a ligature may be fatal; whereas the slighter and temporary disturbance of moderate compression may be safely borne.

The conclusions we draw from all these considerations are as follows:

(1) Where there is any reason to fear that the effect of a ligature may embarrass the heart too much, cause the rupture or enlargement of an internal aneurism, or produce gangrene of the limb, moderated compression is to be employed.

(2) Where the artery affected is extensively diseased, compression is to be preferred.

(3) Where, in other cases, the patient is of an irritable or sensitive nature, and intolerant of restraint, or the aneurism is acute, of large size, rapidly growing, and full of fluid blood, and it is therefore necessary to obtain a rapid and marked effect, ligature is to be recommended.

(4) In other cases, in the absence of any of these special conditions, compression should first be tried, the effect being as closely as possible approximated to that of ligature; if it be not quickly successful, ligature should be practised. Long-continued compression, when unsuccessful, diminishes the probable success of subsequent ligature.

Flexion is specially adapted for aneurisms of small size which contain some clot; it is a safe, simple, and rapid means of cure.

Esmarch's bandage should not be employed when there is evidence of considerable impediment to the circulation of a part, or in aneurisms of rapid growth, or where diffusion is threatened. It is ill adapted for patients with disease of the heart or internal aneurism; in other circumstances it is a rapid and safe method of cure if properly applied, and if the clot formed is carefully protected.

An inflamed aneurism is best treated by Hunterian ligature. The lessening of the force of the blood in the sac, and of the supply of blood to the sac and surrounding tissues, may arrest the inflammation. If suppuration occurs, the danger of hæmorrhage is lessened by the operation.

A suppurating aneurism should be freely opened, and if bleeding occurs, the limb should be amputated; if it does not, a tourniquet should be placed in position on the artery, and an attendant should always be at hand ready to screw it down should bleeding come on.

A diffused aneurism generally necessitates amputation. Where the escape of blood from the sac is slight and gradual (a mere leakage) Hunterian ligature is the best course, but at the first sign of gangrene the surgeon must be prepared to amputate.

Amputation is required in cases of gangrene, in diffused aneurism with threatened gangrene, in suppuration of an aneurism with hæmorrhage, and in the case of an aneurism accidentally opened or complicated with disease of a bone or joint. The limb should be removed above the aneurism.

Dissecting Aneurism.

This form of aneurism is more frequent in women than in men, and in cachectic than in robust persons. It occurs most often in the aorta, and may extend as far down as the femoral artery, or up to the bifurcation of the common carotid trunk. After extending a certain distance in the wall of the artery, the blood may burst through a softened patch of intima into the vessel again; or it may burst externally through the adventitia and become "diffused;" on the other hand, the passage of the blood may be arrested, the aneurism forming a kind of diverticulum in the artery; by projecting inwards it may then seriously impede the passage of blood through the vessel. These cases are rarely diagnosed. At the time of their formation they cause a sudden severe pain shooting along the affected vessel, with enfeeblement of the pulse beyond, and syncope. There is no known treatment for this condition.

Section II. Traumatic Aneurism.

Etiology.—*Wound of an artery treated by inefficient compression.* Arteries are often involved in stabs and punctured wounds, and the free arterial bleeding is arrested by a pad and bandage. If the pressure is sufficient and exact, the wound in the vessel is closed by it and then cicatrises. But if the pressure merely closes the wound in the skin and subjacent tissues, and allows blood still to flow from the artery, even in a small quantity, it collects about the wounded vessel and coagulates; around the coagulum lymph is thrown out, which organises into fibro-cellular tissue and forms a sac; meanwhile fluid blood continues to force its way out of the artery and to expand the clot and sac, especially when all external pressure or support is removed. The aneurism thus originating has a sac of new formation, none of the coats of the artery participate in it, and as the tumour expands this sac not only stretches but grows; it is usually lined with blood clot or laminated fibrin. *The yielding of a cicatrix in an artery* is another but less common mode of origin; this occurs as a sequel to small wounds of large arteries, the cicatrix formed being unable to resist the pressure of the blood. *Wound of an artery* *by a fractured bone* may lead to the formation of an aneurism in the same way as a wound inflicted from without. *Subcutaneous rupture* of an artery from severe strains or during the occurrence or reduction of a dislocation, may be followed by a circumscribed effusion of blood still communicating with the artery, and around which a more or less perfect sac may be developed by the matting together of parts or the organisation of plastic lymph.

Varieties.—When the blood is encapsuled by a complete and distinct sac, the aneurism is called *circumscribed.* When, however, the sac is incomplete, the fluid blood being surrounded by little else than blood clot, which readily yields before the pressure of the circulation, it is called *diffused.* Where the escaped blood is freely diffused without any limitation at all either by sac or clot, it is best described as a case of *ruptured artery*, and not as an aneurism at all.

Terminations.—The aneurism may undergo *spontaneous cure* by the gradual coagulation of the blood in the sac; this tendency is more marked in traumatic than in idiopathic aneurism, the healthy state of the heart and arteries accounting in some measure for this fact. The aneurism may steadily grow, and then may cause *suppuration;* or it may *burst externally*, or the sac may rupture and the blood be extravasated in the part, and cause *gangrene* by compressing the vessels, and arresting the circulation in the parts beyond.

Signs.—Aneurisms formed by subcutaneous rupture are most common in the ham and the axilla; those following wounds are common in the scalp, hand, and foot. The signs of a *circumscribed traumatic aneurism* are like those of a sacculated aneurism, but, in addition, a scar in the skin or a distinct history of injury points to the nature of the case. The signs of a *diffused traumatic aneurism* are less definite. A swelling occurs in connection with an injury, situated over an artery, its outline is ill defined; this swelling steadily, perhaps rapidly, increases and becomes tense, the skin over it being stretched and blue. There may be no pulsation in it, or only a feeble throb; a bruit is generally to be detected, and often a more or less distinct vibratory tremor or thrill. In the arteries beyond the swelling the pulse is weak or absent, the tissues become œdematous, and the surface is cold, benumbed, and feels heavy to the patient, who complains of more or less severe pain; the swelling may be so great as to prevent altogether an examination of the pulse. The pain is generally markedly relieved by proximal compression of the main artery of the part.

Treatment.—It is important to remember that many traumatic aneurisms undergo spontaneous cure, and, therefore, in the absence of special indications demanding instant operation, it is well to wait to see how far nature is able to cope with the case. For *circumscribed traumatic aneurism*, in addition to the general treatment already described, the part should be raised and direct pressure made upon the sac, either by the hand or by a pad and bandage. When this does not succeed, Esmarch's bandage (or, if at the knee or elbow, flexion) should be tried. Failing these means, the surgeon has a choice between the double ligature, proximal compression, or ligature. Where the aneurism and the artery from which it springs are superficial, the double ligature is not a very difficult operation, and if the vessel is healthy, it is not dangerous. Where the aneurism is deep the operation is very difficult, and proximal compression or ligature should be practised. The ligature is often preferred to compression on account of its greater simplicity, and especially when the artery is healthy.

Where *aneurism complicates fracture* the pressure of the splints and bandages used for the fracture generally suffices to cure the aneurism; if not, the main artery above should be compressed. In these cases the union of the fracture is generally delayed. For *diffused traumatic aneurism* the only satisfactory treatment is the double ligature of the wounded artery. This operation is one of considerable difficulty and danger from hæmorrhage. When it is evident that the extravasation is rapidly extending, or gangrene threatens, no time should be lost; but where the tumour is not enlarging so fast, and the circulation is not dangerously interfered with, it is best to wait, with the hope that a sac may form around the blood clot, and that then the Hunterian ligature may be practised with success.

Section III. Arterio-venous Aneurism.

An abnormal communication between an artery and a vein constitutes an arterio-venous aneurism. When the artery and vein are adherent together, and the blood passes directly from the one to the other, the condition is known as *aneurismal varix,* because the essential feature of the case is an aneurism-like dilatation of the vein. When, however, between the two vessels an aneurism is developed, which communicates with both, the condition is known as a *varicose aneurism*, the existence of the aneurism being the most important fact.

Aneurismal Varix.

Etiology.—A direct communication between a vein and an artery may be congenital, more often it is traumatic, rarely is it idiopathic in origin. The common cause is a simultaneous wound of an artery and vein, as in careless phlebotomy, stabs, gun-shot wounds, etc. The edges of the adjacent wounds in the vessels adhere, and then blood passes directly from the artery to the vein. It may be that there is a single wound in each vessel from a stab; more commonly the vein is pierced by a lancet in two places, then the superficial wound heals up, and the deep one adheres to that in the artery. A remarkable case is recorded in which the median basilic vein, one of the humeral veins, and the brachial artery were simultaneously wounded; the result was that the brachial artery and vein adhered together, and the brachial and median basilic veins, so that the blood passed from the artery first into its companion vein, and then into the superficial vein. More rarely a communication between adjacent vessels occurs spontaneously; in one case it was the result of long-continued compression of the femoral artery in the groin. In the days of bleeding this affection was much more common at the bend of the elbow; it has been observed in in the neck, skull, axilla, abdomen and thigh.

Pathology.—Whatever the original shape of the aperture between the two vessels, it soon becomes rounded, smooth, and thickened. The vein is thickened and dilated into a globular or fusiform pouch, and the dilatation spreads in both directions, affecting not only the trunk, but the collateral branches as well; below the wound the dilated veins are tortuous and pouched, above they are simply enlarged. The artery for some distance above is dilated, and its walls are thinned; below it is sometimes narrowed, but at others dilated; the dilatation is said not to affect the branches of the artery. The interior of the venous pouch may exhibit atheromatous changes. The blood pressure being much greater in the artery than the vein, blood is forced into the vein; this first dilates the vein opposite the aperture between the two, then causes obstruction to the return of blood through the vein, and dilatation of its branches below, and the vein above enlarges to accommodate the greater amount of blood returning to the heart.

Signs and diagnosis.—The first sign is the presence of a soft compressible, often ill-defined, tumour in the course of a vein, into which dilated veins can be traced both above and below. This tumour is the seat of forcible expansile pulsation, a very loud continuous rasping, purring, hissing or rushing bruit, and a continuous vibratory thrill. On raising the limb the tumour shrinks and the pulsation lessens; on depressing it the size of the tumour and the force of the pulsation increase. When the artery above is compressed, not only does the tumour lose its pulsation, but it shrinks and disappears. The pulsation bruit and thrill are most intense just opposite the opening between the two vessels, and there the bruit and thrill are continuous, but increased with each beat of the heart; if traced for some distance along the dilated veins in both directions, they grow feebler and lose their continuous character and become intermittent. The bruit may be audible to the patient himself or even to bystanders. The dilated condition of the artery is at times very apparent. The limb below may be œdematous, cold, with feeble pulse; but in some cases the skin is hotter, and the part is hypertrophied: obstinate ulcers with a tendency to bleed sometimes occur. The patient may suffer acute pain in the tumour, or only a sense of numbness and weakness in the limb below. It is often noticed that the symptoms increase up to a certain point and then remain stationary. A scar over the swelling generally points to the nature of the case.

Treatment.—As a rule it suffices to apply some form of external support to the part, *i.e.* a bandage or an elastic stocking. Should more active measures be required, the artery should be tied above and below the communication with the vein.

VARICOSE ANEURISM.

Etiology.—This form of aneurism may be *idiopathic or traumatic.* In the former case a spontaneous aneurism opens into an adjacent vein; this has been observed in the thorax, abdomen, and groin. A simultaneous injury of an artery and vein is a more

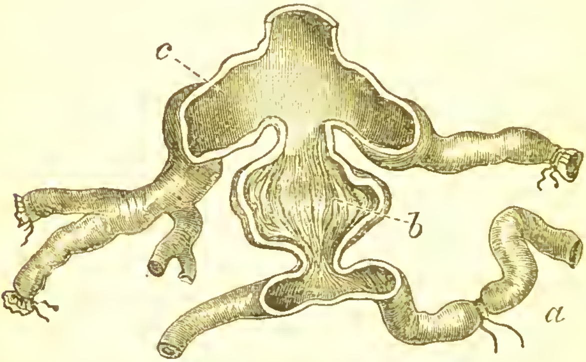

Fig. 27.—Varicose Aneurism at Elbow.

a, Ulnar artery; *b*, aneurism partly filled with clot; *c*, dilatation of median basilic vein. (After Erichsen.)

common cause. In place of the wounds in the two vessels being sealed up, or cohering together, a circumscribed aneurism develops between them communicating with both; this most often happens in careless phlebotomy, stabs, or gun-shot injuries. An aneurismal varix may develop into a varicose aneurism by the gradual yielding of the cicatrix uniting the two vessels.

Pathology.—The mode of production is that of circumscribed traumatic aneurism from a wounded artery with the addition of a wound in a vein. The relative position of the arterial and venous openings in the sac varies much; a case is recorded where two veins communicated with an aneurism, there being four venous openings in the sac. A more interesting case is one in which the deep wound in a transposed vein cohered to that in an artery, the superficial wound in the vein did not heal up, and the blood escaping from it formed an aneurismal tumour ; the blood then flowed from the artery through the vein into the aneurism. The changes in the veins are like those in aneurismal varix. Traumatic varicose aneurisms are usually of small size, and their sacs may contain very little, if any, fibrin owing to the direct passage of blood through them. The venous communication may be shut off, and the case reduced to one of simple aneurism ; spontaneous cure is very rare ; on the other hand, the aneurism may steadily enlarge and rupture.

Signs and diagnosis.—The signs of a communication between an artery and a vein are the same as in aneurismal varix. In addition to the phenomena of that disease there are certain others. It may be possible to distinguish two tumours or two parts of one tumour, one formed by the dilated vein, soft and easily compressible, the other firmer, formed by the aneurism ; this is rendered clearer if, when the artery above is compressed, the dilated vein collapses, but the aneurism can be felt as a distinct tumour. In addition to a continuous loud bruit, a systolic soft blowing aneurismal murmur may be detected. By careful examination it may be discovered that pressure on a certain point stops the thrill and the loud rasping bruit without arresting the pulsation in the aneurism itself. All these special signs point to the existence of an aneurism in addition to the arterio-venous communication. In other cases the existence of an aneurism is known, and the communication of it with a vein is recognised by the marked venous dilatation, not merely below the tumour, but over and above it ; by the very marked thrill and pulsation in the veins, and by the peculiar character of the bruit that is developed.

Treatment.—For traumatic varicose aneurism, in addition to constitutional measures direct pressure may be tried. If that fail, the treatment by Esmarch's bandage should be tried; if this does not succeed, the surgeon may try compression of the artery combined with digital pressure over the communication between the sac and the vein; and, as a last resource, a double ligature should be placed on the artery. To do this the limb is rendered bloodless, and the dilated vein is laid open; from that the surgeon lays open the sac of the aneurism, and then in the wall of this second cavity he will see the opening of the artery, and must tie the vessel above and below it.

SPECIAL ANEURISMS.

Aneurism of the aorta.—All varieties of spontaneous aneurism have been met with in the aorta, where the disease is more frequent than in any other artery.

Any part of the aorta may be implicated; aneurism is most common in the arch, especially in the ascending portion, and least common in the abdominal aorta. It is not uncommon to find a combination of fusiform and sacculated aneurism, and very rarely more than one aortic aneurism may be found. Below the diaphragm the favourite seats are opposite the cœliac axis, and at the bifurcation. In the arch the tumour most often projects from the convex side, but it may spring from any part, and the aneurism may grow forwards or backwards, inwards, outwards, or upwards.

Diagnosis of aneurisms at the root of the neck.—The surgeon having arrived at the conclusion that a given tumour at the root of the neck is an aneurism, must further determine from what artery it springs.

1. *Apparent origin.*—An *aortic aneurism* may sometimes be detected within the chest before it appears at the root of the neck; when this is not the case its first appearance in the neck may exactly resemble that of an innominate or carotid aneurism; an aneurism of the second part of the arch may project immediately above the episternal notch. An *innominate aneurism* first appears behind and above the inner end of the clavicle, and fills up the hollow between the two heads of the sterno-mastoid muscle. A *carotid aneurism* bulges forwards beneath the inner head of the sterno-mastoid. A *subclavian aneurism* appears first in the posterior triangle, or beneath the outer head of the sterno-mastoid.

2. *Direction of growth.*—An *aortic aneurism* may extend in any direction; the detection of a considerable tumour within the thorax renders the diagnosis clear. An *innominate aneurism* may be of a globular shape and project forwards, or it may extend along either of its branches. A *carotid aneurism* grows up the neck along the sterno-mastoid, while a *subclavian aneurism* usually extends horizontally along the upper border of the clavicle.

3. *Limits.*—No lower limit can ever be felt to an *aortic* or *innominate* aneurism, but the finger can often be dipped down below a *carotid* aneurism, or to the inner side of a *subclavian* tumour.

4. *Pressure effects.*—The pressure signs are closely similar in the different cases. Pressure upon the left recurrent laryngeal nerve would distinguish an aortic aneurism from one situated on the right vessels; pressure on the right nerve in a similar manner excludes an aortic aneurism. Pressure on the left innominate vein indicates aortic aneurism rather than

innominate; compression of the internal jugular or subclavian vein only, points to carotid or subclavian aneurism.

5. *The pulse* in the branches of the great arteries is perhaps the most useful sign of all. Where the pulse in the two radial arteries is exactly similar, it shows that the aneurism is situated on the first part of the arch, and in such a case we should expect to find the dicrotic wave lost, and the other changes in the sphygmogram described on page 425. If, however, the left radial pulse is aneurismal and the right is normal, it would point to an aneurism of the transverse part of the arch beyond the origin of the innominate trunk, or of the left subclavian, and the condition of the pulse in the branches of the left carotid artery would determine this. When the right radial and carotid pulses are aneurismal, and the left are normal, it indicates an innominate aneurism; where, of these, only one is aneurismal, it shows an aneurism of the corresponding branch of the innominate artery only. It must be remembered that the pulse may be lost in an artery by the sac of an aneurism of a neighbouring trunk compressing it, or occluding it by displacement or by a plug of clot. The special characters of the "aneurismal pulse," and not the loss of pulsation, are the guide to the seat of an aneurism.

Aneurisms of the innominate artery are always *spontaneous*. They may be either fusiform or sacculated, and may affect the origin, the centre, the termination, or the whole length of the artery. Aneurism of the origin of the artery is always associated with dilatation of the arch of the aorta. The tumour may extend forwards, bulging the sternum, clavicle, and first rib; or upwards into the neck over the carotid artery, where it has reached as high as the cricoid cartilage; or backwards and inwards towards the trachea and spine, or outwards along the subclavian artery; or pouches of the sac may extend in several or all of these directions; growth outwards is most common. The tumour is usually first observed behind the sternal origin of the sterno-mastoid, and as it grows it displaces this muscle, or the sternum and clavicle, or the trachea. It may not project at all, but merely give rise to dulness over the sternum and beneath the inner end of the clavicle. There may be no bruit, but on auscultating the tumour the heart's sounds are heard with extreme distinctness. The special symptoms are an alteration of the pulse in the radial artery and the branches of the external carotid; dyspnœa and alteration in the voice from pressure upon the recurrent laryngeal nerve or the trachea, or both; dysphagia from pressure upon the œsophagus; and cyanosis and œdema of the right hand and arm, and of the right side of the face, head, and neck, from pressure upon the innominate vein; the œdema may extend to the whole of the head and face. The patient often experiences pain down the arm and weakness in it, from pressure upon the brachial plexus, and also shooting pains in the neck and head from irritation of the superficial cervical plexus. Pressure upon the sympathetic nerve may cause permanent dilatation of the arteries of the same side of the head and face, with abundant sweating. Spontaneous cure has been noted in one case only; the disease tends to cause death by asphyxia from pressure, or by bursting either externally or into the trachea, œsophagus, or lung.

Treatment. — Careful constitutional treatment should first be well tried, and digital compression of the carotid artery may be combined with it. When these means fail, the simultaneous ligature of the common carotid and subclavian arteries should be practised. It is not enough to tie one of these trunks, because the free current of blood still flowing through the parent vessel would prevent its success; even when both are tied, the flow of blood to the branches of the subclavian may be sufficient to prevent obliteration of the sac. Should the size of the aneurism prevent the ligature of one or both of these arteries, or the operation fail to cure, the careful introduction of steel wire into the sac, and galvano-puncture, are the only other means at the disposal of the surgeon.

CAROTID ANEURISMS.

Spontaneous aneurism of the common carotid artery.—Its most common seat is at the bifurcation of the trunk; next in frequency, it occurs at the origin of the right artery but never at the aortic end of the left artery. Commencing as a small tumour, the aneurism may grow very slowly and remain unaltered for years; or it may attain a large size, filling up the neck from the chin to the sternum. In addition to the usual signs of aneurism there may be great dyspnœa, with frequent spasmodic cough, which may end in asphyxia; hoarseness and loss of voice, dysphagia, tinnitus aurum, dimness or loss of sight, giddiness, stupor, hyperæsthesia of the scalp, and a sense of pulsation referred to the whole of the same side of the head. These symptoms are the result of compression of the larynx, trachea, pharynx, œsophagus, jugular vein and recurrent laryngeal nerve, or of interference with the blood supply to the brain. The aneurism may undergo spontaneous cure, but much more often it ruptures externally or into the trachea, pharynx, or œsophagus, with rapidly fatal hæmorrhage.

The *diagnosis* of carotid aneurism often presents great difficulties, but careful attention to the points mentioned above (page 458) will prevent mistake. *Tumours of the thyroid gland* are distinguished by their rising and falling with the trachea in deglutition, by their fixedness on their inner side, often by the implication of the isthmus, and by their mobility over the carotid artery. *Glandular tumours* are globular, ovoid, or lobulated in outline; often multiple, generally incompressible and freely movable away from the artery. When the artery passes through the middle of the tumour it may be somewhat compressible, and is not movable over the vessel; but in such a case the outline of the swelling, its history, and the presence of other enlarged glands, and of some obvious cause for the swelling, one or all, clear up the diagnosis. *Abscess* over the artery is distinguished by the usual signs of inflammation, by obvious fluctuation, and by the irreducibility of the swelling when the artery is compressed below. When the artery has opened into an abscess cavity, the signs of inflammation and the absence of the clearly defined outline of the swelling are the chief points in the diagnosis. *Varix* of the internal jugular vein is a soft, compressible tumour, which shrinks during deep inspiration, and becomes fuller when expiratory efforts are made; the pulsation in it is not truly expansile. Other *solid tumours*, fatty or sarcomatous, must be distinguished by their outline, mode of growth, mobility from the artery, and incompressibility.

Treatment.—Digital compression of the artery below the aneurism has been successful in many cases, and should be tried wherever practicable; if possible the artery should be controlled without pressure upon the vagus nerve. Ligature of the artery either below or above the tumour is the other chief means of cure, the proximal ligature being preferred in all cases where there is room to apply the thread between the tumour and the sternum. Manipulation, and the introduction of foreign bodies, should not be employed; the danger of cerebral embolism is too great. Suppuration of the sac is liable to follow ligature of the artery; the pus should be evacuated by an early incision, and if hæmorrhage occurs the sac must be freely opened and the bleeding point tied. The chief danger of the operation, however, is cerebral anæmia, followed by white softening, or by the passive congestion which may follow the ligature of an artery in any other situation. Immediately on tightening the thread there may be syncope, dimness of sight, tinnitus and giddiness; and if softening occurs, convulsions, hemiplegia, and death may ensue. Another frequent complication is pulmonary congestion, which is liable to run on to hypostatic pneumonia; the probable explanation of this is the interference with the circulation in the brain and medulla caused by the operation. It is noteworthy that the effects of sudden closure of the carotid artery are much more grave than when the obstruction is gradual. A patient has lived for some time with both carotid and both vertebral arteries obstructed. Simultaneous ligature of the two carotid arteries is fatal from coma, but if an interval of two to three weeks be left between the ligature of the two vessels, the danger of cerebral disease is not greater than if one only is tied.

Spontaneous aneurism of the internal carotid artery in the neck is chiefly of importance from its great tendency to bulge into the pharynx, and even to simulate an abscess of the tonsil. It should be treated by digital compression or ligature of the common carotid artery.

Spontaneous aneurism of the external carotid artery may, by pressure upon the hypoglossal nerve, cause paralysis of the same side of the tongue. Owing to the number of branches arising close together from the trunk, recurrent pulsation is apt to occur. The disease should be treated by digital pressure on the common carotid artery, and that failing, by ligature. If possible the ligature should be placed around the external carotid artery, if not upon the parent trunk. Recurrent pulsation should first of all be treated with rest and careful direct pressure, and then by incision of the sac and ligature of the branches opening into it.

Traumatic carotid aneurism is very rare, because wounds of the artery are usually fatal; or if recovered from are generally combined with wound of the vein. They should be treated by pressure or ligature of the common carotid artery.

Aneurismal varix has, in one recorded case, arisen spontaneously between the common carotid artery and the internal jugular vein; more often it is caused by sabre cuts, etc., the weapon passing through the vein into the artery. The affected vessels may be, in order of frequency, the common carotid artery and the internal jugular vein; the internal carotid artery, and the internal jugular vein; the common carotid artery and the subclavian vein; and the external carotid artery and the internal jugular vein. At once after the injury there is a considerable effusion of blood in the cellular tissue of the whole side of the neck, which may threaten asphyxia; this is absorbed, and then the characteristic symptoms of the varix manifest themselves. The patients are liable to headache, giddiness, and other signs of cerebral congestion, and also to palpitation, perhaps from arterial blood in the right auricle. The bruit may interfere with sleep; treatment should be palliative only. Leeches may be applied to relieve the congestion of the brain when severe.

Varicose aneurism of the internal carotid artery close to the skull has occurred once.

Traumatic aneurism of the temporal artery may result from accidental or intentional wounds. It should be treated by laying open the tumour and tying each end of the artery.

Aneurism of the subclavian artery is much more common in men than in women, and on the right side. It may arise from any part of the artery except the first part on the left side; usually it attains the size of a hen's egg, but may be much larger. Generally the tumour grows into the posterior triangle of the neck, but it may bulge forwards the sterno-mastoid muscle, or even project above the clavicle; in other cases it grows downwards and backwards towards the pleura, which then becomes thickened and adherent to the lung, and the lung may blend in the sac of the aneurism. The radial pulse is weakened and delayed; there is often œdema of the arm (and in one case gangrene) and distension of the external jugular vein. From pressure upon the brachial plexus the patient may suffer from pain down the arm, numbness or muscular weakness, and pressure on the phrenic nerve may cause spasm of the diaphragm. This aneurism is very prone to undergo spontaneous cure; but it may steadily enlarge and burst externally or into the pleura.

Treatment.—Constitutional treatment should be most carefully tried; but if surgical means are demanded, the choice lies between compression and proximal and distal ligature and direct coagulants. If the case is such that the artery can be compressed with the finger on the cardiac side of the tumour, this is the best treatment; very often it is impossible to compress the artery in this way. In that case coagulants might be tried, or the introduction of aseptic wire into the sac. Where practicable, a proximal ligature should be placed upon the artery, but this is rarely possible. Ligature of the innominate has only once out of sixteen operations been successful, and in no one out of fourteen cases has ligature of the right subclavian in the first part of its course succeeded. This result is partly due to the inherent difficulty of the operation. and the great danger of secondary hæmorrhage from the very free supply of blood to the part, and the proximity of large branches to the ligature. Distal ligature has not yielded any success. Where active surgical means are required, if possible a ligature should be placed on the vessel nearer the heart; but if from any course this is impossible or imperils the sac, or fails, the arm should be amputated at the shoulder joint, and the vessel may be ligatured above the aneurism as the first step of the operation if it can be secured. By removing the limb the blood passing into the subclavian artery is greatly diminished, and there is no enlargement of the scapular branches arising from it; hence there is a good chance of the sac consolidating. It must be admitted that the surgical treatment of subclavian aneurism is very unsatisfactory.

Although strain and over-use of the right arm play an important part in causing spontaneous aneurism, there is no case recorded of true *traumatic aneurism* from wound of the vessel; such a wound is rare on account of the position of the vessel, and the hæmorrhage is quickly fatal. There are, however, at least two cases recorded of *aneurismal varix* from stabs; the signs resemble those of aneurismal varix of the carotid artery. Gentle external support is all the treatment required.

Aneurism of the vertebral artery is always traumatic in origin. Galvano-puncture or the introduction of steel wire into the sac might be tried; if these failed to cure and the tumour threatened to burst, it should be laid open, and the orifice of the artery carefully and firmly plugged; the artery cannot be tied where it lies between the transverse processes of the vertebræ.

Aneurism of the axillary artery.—*Spontaneous.* Injury plays a frequent and important part in the production of spontaneous axillary aneurism, owing to the free movement of the arm at the shoulder joint, and the frequency of injuries to the shoulder and of displacements of the humerus. The disease is much more common in men than in women, and on the right than the left side. The tumour may form on any part of the axillary artery; owing to the laxity of the surrounding tissues it grows rapidly and attains a large size. Most often it projects forwards between the clavicle and the pectoralis major muscle; it may grow up under the clavicle into the clavicular triangle; the strong axillary aponeurosis retards its downward progress. The tumour, if large, interferes with the movement of the arm, especially preventing its abduction; the head may be held inclined to the same side, and the outer end of the clavicle may be pushed upwards. By pressure upon the axillary vein it causes blueness and œdema of the hand, fore-arm, and arm, and afterwards of the chest wall; there is often severe lancinating pain down the inner side of the arm to the elbow, and weakness, numbness, or even paralysis may result from the pressure on the brachial plexus. The aneurism may burst into the shoulder joint, or erode the humerus, or extend in between the ribs and displace the lungs. From the great size of the sac and the looseness of its surroundings, it is specially liable to inflammation; when the venous obstruction is very great, gangrene may ensue. From the obstruction of the artery the brachial or radial pulse may be lost.

Treatment.—Cases of spontaneous cure are extremely rare. The surgeon should first of all treat the disease by digital pressure of the subclavian artery just above the clavicle, where it lies upon the first rib; and if necessary, the patient may be placed under an anæsthetic while continuous pressure is maintained. At the same time gentle direct compression of the sac may be of service in compensating for the absence of the compression by the tense tissue which usually surrounds an aneurism. Where the aneurism has so spread up into the neck, or so raised the clavicle that digital compression of the subclavian artery is impracticable, Esmarch's bandage may be applied to the limb up to the sac for one to two hours, with a view of leading to coagulation of the blood. Should these means fail, the subclavian artery should be tied in the third part of its course, or in the second part if the vessel is encroached upon by the tumour or is found very diseased. This operation may be rendered very difficult by the proximity of the sac or the displacement of the clavicle. Secondary hæmorrhage may occur after this operation, and should be treated by a carefully applied compress ; gangrene is rare, owing to the freedom of the anastomotic circulation. Two special dangers attend it, inflammation of the aneurism, and inflammation of the thoracic contents. This last complication is the most frequent cause of death ; it may take the form of pleurisy, pneumonia, or cellulitis in the anterior mediastinum with secondary pericarditis. The causes of these complications are wound of the pleura at the time of the operation, implication of the pleura in the wall of the aneurism, rupture of an inflamed aneurism into the pleura or lung, injury to or division of the phrenic nerve, and the extension of septic inflammation along the cellular tissue between the scaleni muscles, which is continuous with that in the anterior mediastinum. Where the aneurism is situated low down, it has been recommended to tie the first part of the axillary artery, but it is much better to tie the subclavian. In the case of a very large axillary aneurism it has been advised to tie the subclavian artery, and then at once to amputate at the shoulder joint.

Inflamed axillary aneurism.—The inflammation may arise spontaneously or after ligature of the artery above; in the latter case, the inflammation may spread from the wound to the sac direct, or it may result from the sudden solidification of a large quantity of blood. The condition is recognised by the onset of pyrexia, with increasing swelling of the tumour, local heat, redness, and pain; then fluctuation may be detected, an abscess burst, and the escape of discoloured pus and coagula be followed by free arterial bleeding. The abscess may, however, burst into the pleura, or into a bronchus, and the pus be coughed up. If suppuration occur after ligature of the subclavian artery, an early incision should be made into the fluctuating part, and if bleeding occur, an attempt should be made to tie the bleeding vessel, and failing this the limb should be amputated. When occurring spontaneously, amputation is usually indicated; but if the aneurism is small and the sac firm, the subclavian artery may be first tied.

Recurrent pulsation.—If ligature above the sac fail to cure the disease, careful direct pressure should be tried; and if that does not succeed, the surgeon has to choose between employing a direct coagulant such as acupuncture or electrolysis, laying open the sac and tying all vessels opening into it, and disarticulation of the limb. Laying open the sac has been successful, but the milder means should be first tried, and if the "old" operation be undertaken, the surgeon must be prepared to amputate if he be unable to complete it.

Diffused aneurism, or where gangrene is threatened, can only be treated by amputation at the shoulder joint.

Traumatic aneurism is not unfrequent from stabs and other wounds of the part, or from the injury attending dislocation of the shoulder and its reduction. Where the artery is ruptured, and the blood is extravasated without any limiting sac, the subclavian artery should be compressed, the swelling incised, and the artery ligatured above and below the wound; and should the surgeon fail to secure the vessel, he must proceed to disarticulate the limb.

For *sacculated traumatic aneurism*, digital compression of the subclavian artery with careful pressure on the tumour should first be tried, and failing that, this vessel should be tied in the third part of its course. If the sac is very thin, and the aneurism threatens to rupture, it would be better to lay it open, and tie the artery above and below.

Varicose aneurism has been met with in the axilla, but only rarely.

Aneurisms below the axilla are rare, except at the bend of the elbow, as a result of wound of the artery; in other cases they are nearly always associated with cardiac disease and embolism. At the bend of the elbow an aneurism generally tends to grow upwards along the brachial vessels, being limited by the biceps on the outer side, and by the internal intermuscular septum internally; it may extend under the biceps muscle and be flattened in shape. Owing to the proximity of the median nerve pain is often felt along the palmar surface of the thumb, forefinger, middle finger, and the outer side of the ring finger; if the aneurism attains a great size, the flexor and pronator muscles of the fore-arm may be paralysed. The anastomotic circulation of the fore-arm is so very free that it may imperil the success of the ligature, owing to the rapidity and freedom with which blood returns to the aneurism; it also renders the danger of secondary hæmorrhage greater in the arm than in the leg or thigh, while the danger of gangrene is very much less. For these reasons, and because the affection is so rarely due to disease of the arteries, when an aneurism is superficial, the "old" operation is much more frequently applied in the upper than in the lower limb.

Aneurisms at the elbow are nearly always traumatic, and this has been the most frequent seat of traumatic and arterio-venous aneurism.

Spontaneous aneurism should be treated by compression of the brachial trunk above, or flexion, or Esmarch's bandage; and when these means fail, by ligature of the main artery.

Traumatic aneurism should be treated by compression in either of the ways just mentioned; if this fails, a ligature should be applied to the brachial artery, either close above the sac, or at a distance (Anel's or Hunter's operation), and if pulsation still persists, the sac must be incised and the vessels opening into it tied.

Varicose aneurism must be treated by Esmarch's bandage, and that failing, by laying open the sac and tying all the vessels communicating with it.

Aneurismal varix will require only an elastic armlet.

Aneurisms of the fore-arm are to be treated by direct and indirect compression, flexion of the elbow being preferable to other means of compressing the brachial artery; Esmarch's bandage may be used. If these means fail, when the aneurism is superficial in the lower part of the fore-arm it is easily treated by the double ligature; when, however, it is deep under the muscles of the upper part of the fore-arm the brachial artery should be tied. Spontaneous aneurisms below the elbow are usually embolic in origin, and they are, therefore, capable of succcssful treatment by the "old" operation.

Aneurisms of the hand are not common. If spontaneous, pressure upon the radial and ulnar arteries, together with pressure upon the tumour, should be tried; failing that, the brachial artery should be ligatured.

Small traumatic aneurisms of the digital artcries are to be treated by incising the sac and tying each end of the artery; when the palmar arch is the seat of aneurism, direct pressure may be combined with acute flexion of the elbow; if it fails, the brachial artery is to be ligatured.

Inguinal aneurism.—An aneurism in the inguinal region may be connected with the common or external iliac artery or commencement of the common femoral artery. It is most common at Poupart's ligament, and there often grows both up into the abdominal cavity and down into the thigh, the tumour presenting two lobes, with a constriction opposite the fold of the groin. Inguinal aneurism is commonly of slow growth, and may be long unobserved; but it may form a very large tumour in the iliac fossa; the part in the thigh expands less rapidly than that in the belly, owing to its being supported by the strong fascia lata. By pressure on the femoral and internal saphena veins, the tumour causes œdema and lividity of the lower limb; and pain along the front of the thigh or down to the inner side of the knee and instep may be caused by irritation of the genito-crural or anterior crural nerve. The natural termination of inguinal aneurism is external rupture and death from hæmorrhage.

Diagnosis. — Great care is often required in deciding the nature of a tumour in the groin; and when any special difficulty is met with, an examination should be made when the patient is under the influence of an anæsthetic, so that the abdominal muscles may be completely relaxed. The conditions which simulate aneurism are abscess, pulsating tumours, and enlarged glands; in several instances, inguinal aneurisms have been opened in mistake for abscesses. The directions already given will enable a correct diagnosis to be made. An aneurism of the aorta, even of its thoracic part, may extend down to Poupart's ligament, and then form an external swelling, at first sight like that of inguinal aneurism.

Treatment.—Constitutional treatment must be tried first; where that fails, compression, ligature, and coagulants may be resorted to. Proximal compression of the lower end of the aorta by Lister's tourniquet, the patient being under an anæsthetic, has been successful, and where it can be employed should always be tried; compression of the artery beyond the aneurism may be combined with it. Where there is no room for the pad of the aortic compressor above the aneurism, distal compression may be tried, or resort may be had to Davy's rectal lever. This instrument is not suited for cases of aneurism, because the long-continued pressure upon the rectal mucous membrane is likely to be injurious. Where the aneurism is low down in the groin, a ligature may be placed on the external or the common iliac artery, the former if possible, and this has proved very successful. Where the aneurism is situated too high to allow of this, the surgeon has to choose between ligature of the aorta, distal ligature, and the introduction of coagulants. In no case has ligature of the aorta been recovered from; distal ligature has not been known to cure, but is well worthy of a trial; where all these means fail or are inapplicable, galvano-puncture may be tried. The "old" operation has been performed; it is difficult in execution, and dangerous from the liability to profuse hæmorrhage; it may be employed in traumatic aneurism, or in cases of recurrent pulsation. Cure of an inguinal aneurism is liable to occasion suppuration around the sac, owing to the loose cellular tissue in which it lies. A single case of *varicose aneurism* has been recorded; they are not more common, because wounds of this great vessel are generally fatal.

Aneurism of the buttock may spring from gluteal or sciatic artery, and is about as often traumatic as spontaneous. These aneurisms are buried deep in the buttock, and unless large, may long escape notice ; those on the sciatic artery may grow also into the pelvis. The main symptoms are a limitation of the free movement of the lower limb, and pain from pressure upon the great sciatic nerve. At first the tumour is small, firm, and deep, and it may closely simulate a pulsating tumour of bone ; later on in its course it may bear some resemblance to an abscess ; to render certain the diagnosis between abscess and aneurism, an exploring needle should be passed into the swelling, when, if it is an uncured aneurism, bright red blood will escape. One case of spontaneous cure, at least, is recorded, but the general termination of these cases is death from external hæmorrhage. It may be quite impossible to distinguish between a gluteal and a sciatic aneurism ; when it is small, the height at which it is placed in the buttock and an interpelvic examination enable the surgeon to arrive at a right conclusion. The usual constitutional *treatment* should be given a fair trial. An aneurism of the buttock is well adapted for the employment of direct coagulants, *i.e.* galvano-puncture, steel wire, or even perchloride of iron. There is no danger of wounding any important structure in operating, and if portions of clot are washed into the branches beyond the tumour, the embolism is without special danger ; at the same time these aneurisms are particularly badly situated for any other surgical means of arresting their growth. The "old" operation has been performed, but its difficulties, and the danger of secondary hæmorrhage, are very great ; distal ligature cannot be practised, and it is only in very rare cases indeed that there is space to apply a ligature to the artery between the pelvis and the tumour. Ligature of the internal iliac artery has been successful.

Direct pressure upon the tumour may be tried, but with great care, owing to the danger of causing a slough or suppuration.

Femoral aneurism is more common in Scarpa's triangle than in Hunter's canal. The tumour grows in the direction of least resistance, and may attain a large size ; in Scarpa's triangle it is usually globular in shape, and projects through the saphenous opening ; in Hunter's canal it is more flattened in form.

Aneurism of the profunda femoris has been met with. It is distinguished from femoral aneurism by the fact that the pulse in the popliteal and tibial arteries is the same on the two sides, and that the unaltered femoral artery can be traced beating over the side of the tumour in the upper part of the thigh. Femoral aneurism may undergo spontaneous cure, but its natural tendency is to burst.

The surgical means of *treatment* are, first of all, compression of the common femoral artery, and if this fails, either ligature of that trunk or of the external iliac artery. Ligature of the common femoral artery is discarded by many surgeons on account of the proximity to the ligature of one or other collateral branch, which exposes the patient to great risk of secondary hæmorrhage. Further than that, the anastomotic circulation is less free than when either the superficial femoral or the external iliac artery is tied.

Traumatic femoral aneurism, when circumscribed, is to be treated by compression or ligature of the artery above. When there is no distinct sac to the tumour, it should be laid open and the wounded vessel tied above and below the opening in it.

Varicose aneurism has been met with in the groin. Ligature of the external iliac artery has proved unsuccessful, and it would be better in any such case to tie the artery where wounded. The obstruction of both the common femoral artery and vein exposes the patient to great risk of gangrene.

Aneurismal varix in the groin should be treated by elastic support.

Popliteal aneurism is more frequent than any other aneurism except that of the aorta. This frequency is due to several causes: (1) *The contact of the artery with the bone.* (2) The alteration of the length and calibre of the vessel caused by the frequent rapid *movements of the knee joint.* (3) The *want of support of the artery:* all the other main arteries in the lower limb are well supported by muscles or fasciæ; the popliteal alone is surrounded by loose cellular tissue and fat. (4) *The termination of the artery* in small arteries which lie deep among muscles, and in the mouth of which an embolus may be caught. Double popliteal aneurism has frequently occurred, the two tumours being noticed simultaneously, or the second appearing after the cure of the first.

The aneurism may be either fusiform or sacculated, and the latter may spring from either the front or the back of the artery. When springing from the back the aneurism often attains a considerable size, compresses the popliteal vein and nerve, and tends to rupture. Sacculated aneurism of the front of the artery is usually of small size; it is liable to erode the femur or tibia, and cause effusion into the knee joint, or to rupture into the articulation. Popliteal aneurism may spread upwards, and rupture into Hunter's canal, or downwards into the leg and rupture under the calf muscles; or it may burst subcutaneously. Sometimes the patient can state exactly when the tumour developed, but more often its origin and early progress are insidious. The first symptom is often pain about the knee or down the leg to the foot, and stiffness in the knee joint, and the condition is frequently mistaken for rheumatism; if there is effusion into the joint still further support is lent to this error. Pressure upon the internal popliteal nerve causes pain shooting down the limb to the toes, cramps, muscular weakness, and paralysis. Pressure upon the popliteal vein causes cyanosis and œdema. Erosion of the bones or the ligament of Winslow is attended with constant aching or burning pain in the joint itself, with great stiffness of the joint, and pain on attempting to move it.

When a popliteal aneurism opens into the knee joint, the synovial cavity becomes suddenly filled out, the part is hot to the hand, and, if the femoral artery is compressed, the swelling of the knee yields a little to gentle pressure; the introduction of a fine trocar or a grooved needle in any case of doubt will establish the nature of the fluid in the joint.

Popliteal aneurism must be diagnosed from abscess, bursal cyst, pulsating sarcoma, and a solid tumour over the artery. The signs by which the diagnosis can be made have been already mentioned.

Treatment.--Spontaneous cure may occur, and in some cases it is sufficient to place the patient at rest in bed, with proper diet and the affected limb raised. Should this simple treatment fail, *flexion* should be tried if the tumour be small and firm, or *Esmarch's bandage* may be employed.

Digital or instrumental compression of the femoral artery has been successful in a large number of cases; if operation is necessary, the femoral artery should be tied at the apex of Scarpa's triangle, great care being taken not to wound or injure the femoral vein. Should secondary hæmorrhage occur, the wound should be carefully plugged, or the artery religatured where bleeding; and if this be unsuccessful, amputation will be necessary, as ligature of the artery at a higher level either fails to stop the bleeding or causes gangrene of the limb below. Should "moist" gangrene follow the ligature, the limb should be amputated above the knee without waiting for any "line of demarcation"; if the gangrene is "dry," the separation may be left to nature, the mummified part being meanwhile wrapped in iodoform wool. When pulsation recurs and persists after the ligature, digital compression of the artery in the groin, combined with direct compression of the tumour, is generally successful. If not, the surgeon has to choose between amputation and ligature of the external iliac artery. If the patient is old, with diseased heart or degenerate arteries, and the tumour is large, amputation is to be preferred, as the alternative course would be followed by gangrene. When, however, the patient is a young or middle-aged man, with healthy heart and arteries, the surgeon will be justified in tying the iliac artery.

When the aneurism is threatening to become diffused, it is safer at once to ligate the artery above; but if it is already diffused, amputation through the lower end of the femur is the only resource. Simple rupture of the sac into the knee joint should be treated by the Hunterian ligature, in the hope that the aneurism may be consolidated and the blood absorbed from the joint; but if the aneurism has caused caries of the femur or tibia and disorganisation of the joint, amputation should be at once practised. When the pressure of the tumour has caused gangrene of the leg and foot, the only course open to the surgeon is to amputate the limb. If the sac be inflamed, ligature of the artery above, together with appropriate local treatment, may prevent suppuration; if fluctuation be detected an incision should be made, and if profuse hæmorrhage follow, amputation will be the only safe procedure.

Aneurismal varix of the popliteal artery and vein has been several times observed.

Aneurism in the leg and foot is rare, and is often traumatic in origin; it is met with in connection with the posterior and anterior tibial arteries, the dorsal artery of the foot, or the plantar or digital arteries.

Aneurisms in the leg should be treated by Esmarch's bandage, flexion of the knee, or digital pressure in the groin; when these means fail, the Hunterian ligature should be practised.

Digital aneurisms should be treated by incision and double ligature. Aneurisms of the foot are difficult to treat on account of the very free anastomoses between the different arteries; compression of the artery above, or Esmarch's bandage, should first be tried; if that fail to cure, the artery may be ligatured above and below the sac, or galvano-puncture or coagulating injections should be tried.

XXVIII. INJURIES AND DISEASES OF LYMPHATICS.

C. Mansell Moullin.

Wounds and rupture.—The lymphatics are so widely distributed through the tissues that they must often be severed in wounds, but it rarely happens that any serious result ensues except in the case of the largest trunks. The walls collapse at once from the pressure of the surrounding tissues, and the valves prevent any backward flow until the ends are firmly sealed by the lymph that coagulates on the surface.

A few instances have been recorded in which the *thoracic duct* has been injured, leading to the discharge through a fistulous opening of spontaneously coagulating liquid, milky during digestion; and one of rupture without wound proving fatal from general peritonitis, but this vessel is so thoroughly protected in its whole course that such cases are exceedingly rare. In another instance the duct was ruptured opposite an unrecognised fracture of a dorsal vertebra; chyle was poured into the pleural cavity, and led to death from compression of the lung. In the case of other large trunks the freedom of anastomosis, as a rule, prevents stasis, and it is quite exceptional without this to meet with a chronic discharge of lymph (lymphorrhœa).

Inflammation.—The lymphatics are often attacked by inflammation, and this may involve the glands (lymphadenitis) or the vessels (lymphangitis), but probably never the latter by themselves. It may be acute, ending in resolution or suppuration; or chronic, leading to a slowly increasing enlargement, which either remains hard and firm, with an increase in the fibrous part of the gland, or slowly undergoes caseous degeneration, softens and breaks down.

When it is *acute*, the lymphatics alone may be affected. If they are superficial, red lines appear in the skin along their course, much broader, it is true, than the trunks of the vessels themselves, but still not extending widely into the circumjacent tissues. Or they may be inflamed merely as part of the cellular tissue in which they lie. This is particularly the case with poisoned wounds; all the soft tissues on the flexor surface of the limb (not merely that which surrounds the trunks and glands) becoming swollen, red and œdematous within a very short space of time. In this form of diffuse and spreading cellulitis, the affection of the lymphatics is but one feature of the whole. The glands are swollen and tender in advance of the extending inflammation, just as they are in erysipelas and for the same reason, because the poison absorbed from the meshes of the cellular tissue or skin is conveyed to them more rapidly and directly along the cavity of the vessels; but this adds little or nothing to the gravity of the disorder. The constitutional disturbance is so grave, owing to the condition of blood poisoning that rapidly ensues, that the inflammation and suppuration in the glands are only of local significance in comparison.

Lymphangitis is, generally speaking, the consequence of a wound, but this is not an invariable rule. The poison may be absorbed through mucous membranes in which there is no abrasion or scratch to be found, especially in the case of the throat; and it has even been known to penetrate through the unbroken skin of the hand. There is no question that the interstices between the epithelial and epidermic cells are in direct communication with the lymph canalicular system, and through this with the lymphatics, and in all probability it is in this way that the poison gains entrance, its absorption being no doubt greatly facilitated by friction, pressure, or the removal or softening of the outer corneous layer.

Certain kinds of wounds are much more likely to be complicated by lymphangitis than others. The presence of decomposition is especially favourable to its production, not only because poisonous substances are generated during the process of putrefaction, but also because, unless the drainage is very perfect, the contents of wound cavities in which this is taking place are under considerable tension. Recent wounds are much more liable to be attacked than granulating ones; when they have reached this stage all the decomposing shreds have, as a rule, been thrown off by the suppuration, and granulations themselves, so long as they are uninjured, do not absorb, the current setting in the opposite direction, towards the surface. Wounds that are not kept properly at rest, or where there is any discharge pent up, and above all, pustules and poisoned wounds, suffer the most frequently.

Symptoms.—When the superficial structures are involved, red lines make their appearance along the course of the vessels; the cellular tissue that surrounds them and helps to form their external coat, is swollen and hyperæmic. Often the lines are slightly raised, owing to the congestion and exudation round, and tender on pressure; here and there they disappear, where the superficial lymphatics empty themselves into the deeper set, or swell out and become broader opposite plexuses and valves; later on the exudation may increase so much at these points that small abscesses form at intervals along the course before the glands are reached. Either the poison is carried along with the lymph, and affects the walls of the vessels as it passes over them, so that the inflammation spreads outwards to the tissues round, or else it creeps along in the loose cellular meshwork on either side. Probably the former is the correct view; at any rate, in the majority of cases the redness spreads upwards with much rapidity. At the same time there is fever, perhaps commencing with a rigor, corresponding in severity to the extent and the cause of the inflammation.

Lymphadenitis.—Very often the glands show, by their swelling, etc., that they have become inflamed, without there being any perceptible change in the course of the vessels. The hyperæmia and exudation are rarely limited to the glands themselves; the loose cellular tissue in which they lie, and which is traversed by the lymphatics at all points as they make their way to the capsule of the gland, is even more congested, swollen and softened. It depends on the cause that originally excited the inflammation, on the method of treatment adopted, and on the constitution of the patient, whether all this hyperæmia and exudation shall gradually and slowly subside or pass on to suppuration. Whatever the result, glands rarely recover quite their normal character; they nearly always remain hard, with an increase in the fibrous stroma, slightly enlarged, and if, as is often the case, there have been repeated attacks, bound down by adhesions to the surrounding textures.

Suppuration generally commences not in the gland itself, but in the loose cellular tissue round (peri-adenitis), so that when the abscess is opened, an irregular, misshapen body may be sometimes seen adherent to one part of its interior; but this is not the case when the suppuration is very acute, and especially if the cause is the absorption of some virus from the surface of a chancre. It then commences in the interior of the gland itself, and in the latter case the pus that is formed possesses the same power of infection as that secreted by the original sore.

Sometimes, particularly when it is acute, the pain and constitutional disturbance are very considerable. More often, though the local tenderness and pain on movement may be severe, there is only a sense of uneasiness, or a fulness in the part, so long as the patient remains quiet. Not unfrequently, on opening an abscess such as this, it is found to be much larger than was expected, particularly in the axilla, the pus spreading for long distances in the soft, loose, cellular tissue before it breaks through the deep fascia and points under the skin.

Treatment.—In the majority of instances of slight acute lymphangitis, and even when it ends in an abscess, the wound is comparatively small, and often overlooked. It may have healed before the abscess has attracted much attention, especially if the gland is surrounded by loose cellular tissue, as it is in the axilla. Wounds or cuts that have a suspicious origin should be thoroughly washed under a stream of warm water, so as to encourage bleeding as much as possible; and the surface may be cauterised, but this is rarely of much service, either absorption has already taken place, or a much weaker disinfecting lotion will be sufficient. It is equally important to prevent the surface of a wound being irritated afterwards. A very large proportion of cases have their origin in simple wounds that have never been poisoned at all, but which have been continually irritated by friction or in some other way.

Warmth is by far the most agreeable application when the vessels or glands are involved. Sometimes, when in a healthy person the process is very chronic, counter-irritation by the application of nitrate of silver or of iodine to the skin over the inflamed structures assists resolution, but it will often be found that suppuration is quietly making its way round the gland the whole time. In many cases nothing will prevent it. Abscesses should be opened early, and frequently they contain much more than is suspected : if the remains of a gland are visible anywhere in the interior it is as well to enucleate it at once. Arrangements should be made so that the abscesses can drain effectually, and then pressure should carefully be applied, and strict rest enjoined, otherwise not improbably, even in healthy people, loose folds of blue congested skin will be left overhanging sinuses filled with pale flabby granulations. When the suppuration is more deeply seated, and it is a matter of question to which side important structures may have been pressed, it is better to adopt Hilton's method (*see* article on Abscess), and subsequently insert a drainage tube, so that the openings in the skin and the deep fascia may continue to correspond.

In *chronic* enlargement of the lymphatic glands due to inflammation, the exciting cause is of infinitely less intensity ; often, indeed, is so trivial as scarcely to be apparent. The persistence of the process is due either to its continued action or to some peculiarity in the patient's constitution, or to both together. In strumous and scrofulous subjects it is especially common, and its course agrees in all respects with those of the other inflammatory affections met with in these conditions, *i.e.* it originates from some altogether insignificant cause ; it still continues after this has died away, and the products have a marked tendency to undergo fatty degeneration and caseation, and finally break down into pus. (*See* article on Scrofula.) The trunks of the vessels show no change themselves.

The glands are enlarged, painless or only slightly tender, fairly hard at first, and freely movable in the tissue round. It is rare for one alone to be attacked, although the change is much more advanced in one or two in each group; frequently they form chains, especially in the cervical and submaxillary region. On section, so long as they are only slightly enlarged, the structure of the gland is uniform throughout, smooth, soft, and greyish in tint, sometimes, if during resolution the connective tissue part has increased, rather firmer than natural. Then, comparatively speaking, rapidly one or more swell up and become fixed to the surrounding ones; the skin becomes adherent, first dusky red and then dull blue in colour, and if it is left to itself it slowly gives way in the centre, and allows the escape through a long devious channel of broken down caseous material mixed with thin oily pus. The section of the gland is no longer uniform; lining the capsule, which is thickened all over but at one spot, is a shell of adenoid tissue, in which the superficial lymph paths can scarcely any longer be traced. Inside this is a smooth homogeneous greasy mass of caseous substance, with some greenish-yellow pus in the centre. Much of this escapes when the abscess breaks, and burrowing often in a horizontal direction before it bursts through the fascia, and then again, before it reaches the skin, it leaves a long sinuous track leading to a sac lined with almost non-vascular caseous material.

The rapidity with which this process of degeneration takes place, and the number of glands involved, depends largely on the peculiar constitution of the patient. Where there is no strumous tendency, and the glands are exposed to a continuous light irritation, they rather become vascular, enlarged, and hardened, owing to the organisation of the exudation that from time to time is thrown out.

Treatment.—In the treatment of these cases all local irritation must be stopped at once, no matter how slight it may appear to be; constitutional remedies, cod-liver oil, iron, iodine, sea air, are essential. In many patients these glands vary in size, according to the state of health. So long as this is good they are scarcely larger than natural, but at the slightest illness, even a cold, they swell up, become tender, so as to be a common cause of what is known as "stiff neck," and though they do subside again, they rarely shrink to their former dimensions. When they are tender and recently enlarged, the moist even warmth of a wet towel round the neck is most beneficial. Friction should be carefully avoided; iodine painted on the skin at night is in great repute with some, but care should be taken not to raise a blister with it. Injections of tincture of iodine, five to ten minims into the substance of the gland, will sometimes start absorption in those cases in which there is no tendency to suppuration. The iodide of lead ointment laid on thickly, but not rubbed on, every night, and then covered up with oiled silk, is certainly of service.

If suppuration has set in, the abscess should be opened early and freely, so as to allow of the escape of all the shreds of tissue and caseous material. If it can be managed, it is as well to dissect out cleanly the gland which has suppurated; but only too often it is adherent to the others, and forms one link of a chain reaching down among deeper and deeper structures, until it is impossible to reach them. Still it must be remembered that this is the most effectual method when it can be adopted, and, owing to the fact that the incision can be arranged properly, leaves the least scar, and saves the patient the constant formation of abscess after abscess. When this is impossible, the interior should be scraped out thoroughly with a sharp spoon, so as to get rid of the degenerate lymphoid tissue as much as possible, and a drainage tube inserted. If the skin is adherent over a large area, so that it forms the front of a thin-walled sac, it may be perforated with a fine-pointed cautery, or a thread may be drawn through it and left to act as a seton. Sometimes in this way the abscess empties itself slowly, and when the sac collapses leaves only two small perforations. Neither of these plans, however, succeeds well unless the opening in the fascia corresponds with that in the skin, and unless the part is kept thoroughly at rest.

Lymphoma. Hodgkin's disease. — The lymphatic tissues, and especially the glands, are liable to certain forms of enlargement, known by the names lymphoma, lympho-sarcoma, and lymphadenoma, or Hodgkin's disease. The histological features of these growths are identical; they all consist of adenoid tissue. In some there is scarcely any departure from the normal; in others the fibrous element predominates, rendering the glands hard and tough; in others, again, it is the cellular part; or the growth may be modified by degenerative changes.

Clinically they vary immensely; some are purely local in their significance, others are as intensely malignant as the worst form of sarcoma.

They are all most common in young adult life, though they are not by any means confined to this period. In *lymphoma* there is a slow painless enlargement of several glands in one or more regions of the body. There is no sign of inflammation about them; no cause can be found to account for them; they do not appear to be associated with any definite diathesis; sometimes they increase rapidly, and then remain stationary for a period; sometimes their growth is slow and regular. Nearly always the glands remain separate and distinct from each other, so that the surface of the growth is soft, rounded, and lobulated.

It is quite exceptional for them to become firm and hard. The ultimate result is not always the same. Most often under the influence of iron, arsenic, and phosphorus, especially if assisted by good food and fresh air, they remain stationary or slowly subside without injuring the health permanently; but they frequently become caseous in the centre, and then by degrees soften and break down, and sometimes, after lasting quiet for two or three years, they suddenly enlarge, fuse together so as to form an even surface, and press seriously on important structures. In the neck they are particularly prone to do this, forming a kind of collar, in which blood-vessels and nerves are involved beyond all hope. The skin then becomes red and œdematous, so as to give the impression that suppuration is imminent, or that the growth is about to burst through, which, however, it rarely does, in spite of the perfect sensation of fluctuation, unless an incision is made into it. The patient's health begins to fail, emaciation sets in, and, unless some intercurrent attack of inflammation of the lungs or other viscera carries him off, he sinks in a year or two at the most from the commencement of the rapid enlargement, completely exhausted. A case terminating in this way is generally said to have been one of lymphadenoma, but it is very doubtful if it is possible to distinguish it from ordinary lymphoma in the earlier stages, or, indeed, until the constitutional cachexia is well marked.

In *Hodgkin's disease* the growth is met with, not only in the lymphatic glands, but in the viscera as well, and as a rule it occurs in many parts of the body at the same time. Adenoid tissue is so widely distributed that there is no need, for this reason, to regard this disease as disseminated from one primary centre, as in the case of carcinoma; it may merely be the result of a proneness to rapid and unstable over-growth common to the whole lymphatic system. The spleen, as might be expected from its anatomical structure, suffers the most often, then the liver, thymus gland, alimentary canal (especially the region of Peyer's follicles), tonsils, kidneys, and even the bones. The pancreas, ovaries, testes, and heart, possessing little or none of this particular tissue, are usually exempt.

Leucocythæmia sometimes occurs with this, but its presence is not invariable, and nothing is known of its etiology. The prognosis under these circumstances is much more grave; the health fails very soon; anæmia and exhaustion set in almost at once; epistaxis is common, and so are extensive subcutaneous extravasations, which may be mistaken for abscesses; and it soon proves fatal, perhaps quite unexpectedly, from extreme debility, unless pressure on some important internal organ produces a more speedy termination.

Lympho-sarcoma differs from these in being a true sarcoma, and, like all sarcomata of rapid growth or embryonic type, intensely malignant. It may be homologous at first, but it rapidly invades surrounding tissues, and becomes heterologous, growing in all directions, pushing everything on one side, and spreading with extreme rapidity. Often they are so soft and of such rapid formation that they have been mistaken for abscesses. Sometimes, when they occur in the thorax, they displace the heart and lungs, and coming in contact with the front wall of the thorax simulate aneurism; and, owing to their extreme vascularity, they may even pulsate so as to render the imitation still more exact. Growths of this character are usually single. Secondary deposits in other organs may occur, as they do with other forms of sarcoma, but this is usually late in the history of the case.

Treatment. — Operative treatment in these cases is almost useless. When the tumour is still small it may be excised, if in a moderately accessible region, and there is a capsule around, from which it can be shelled out with deceptive ease; but local recurrence within a very brief space is almost invariable. In lymphoma, on the other hand, it is possible to hold out a much better prospect. In many cases the whole mass may be excised, and the patient relieved permanently, or at least freed for a considerable time from all anxiety. But to be successful, such operations must be complete, the sterno-mastoid may be divided, and the great blood-vessels and nerves in the neck dissected out; but no single gland must be left, or else, relieved from the pressure of the surrounding ones, and perhaps assisted by the feebleness of the patient during recovery from so severe an operation, it will grow up again, and rapidly reproduce a tumour as large as the original one.

Obstruction of the lymph channels anywhere, whether in the glands or the vessels, leads to a condition known as *solid œdema*, and to dilatation and hypertrophy of the vessels beyond the seat of obstruction. The latter, however, to which the name of *lymphangiectasis* has been given, may, as in the case of veins, exist independently.

Its pathology under these circumstances is not clear; it may affect the superficial vessels, or the deeper ones; and to maintain the parallel with the veins, the walls of the vessels may give way and lead to the discharge of lymph or chyle, as the case may be, either on the surface of the body or into one of the viscera, such as the bladder. The skin or the mucous membrane is generally found much thickened, and traversed by lacunæ of varying diameter, freely anastomosing together. The surface is irregular, covered over with vesicles which break, discharge a large amount of fluid for a variable time, and then perhaps scab over and heal up again.

The most frequent cause of obstruction is inflammation affecting either the glands or the vessels, especially if the attacks are often repeated ; but it may arise from gradual compression of the thoracic duct by aneurism, glandular or other tumours (if the patient live sufficiently long), from the presence of parasitic worms, and much more commonly from cancerous infiltration such as that which takes place in the axilla after removal of the breast, or as a late result of diffuse suppuration in the cellular tissue of a limb. The œdema is distinguished from that due to simple venous obstruction, not only by its dense solid feel, but by its extraordinary persistency. It may or may not be associated with dilatation of the lymphatic vessels ; that appears to be quite uncertain in each case. Sometimes the skin remains perfectly smooth, especially when the over-growth is due to some central or deep-seated obstruction, and affects mainly the cellular tissue ; at others it is rough, irregular, and even tuberculated, marked with scars, or ulcerated. Probably this roughness is due to repeated attacks of local inflammation, each of which leaves the part it involves a little thicker and a little more irregular than it was before, until at length a condition is produced not to be distinguished from that known as *elephantiasis Arabum.*

When this is once reached, there is no limit to the size the affected part may attain. The looser the cellular tissue, the more easily œdema takes place, and the more rapidly it grows until, as in the case of the scrotum, the weight may be so great that the patient cannot stand. The whole of the increase is due to the over-growth of the tissue elements of the cellular tissuo and the skin, and to the accumulation between them of stagnant lymph ; the muscles and the other textures generally waste, although the veins may sometimes become varicose.

Treatment.—The exciting cause of conditions such as these is, in general, beyond the reach of treatment. If the scrotum or the penis is involved, the testes and the corpora cavernosa and spongiosum may be dissected out, and the whole hypertrophied mass cut off, either with the scalpel, or with the actual cautery if hæmorrhage is much feared, with a very fair prospect of success. Ligature of the main artery going to the limb has been practised in severe cases, and sometimes the result has been good, though it is difficult to say for what reason. Otherwise the treatment resolves itself into facilitating the return of the lymph, and promoting the absorption of that which is stagnant, as much as possible, by means of position, friction in an upward direction, the inunction of mercury, the application of belladonna, and above all steady, uniform pressure, for which nothing answers better than Martin's elastic bandages. Where these can be applied, if the obstruction is not absolute, as it only too frequently is in the case of carcinoma, the increase in size may at least be kept in check.

The lymphatics in certain congenital deformities.—Closely allied to this form of overgrowth, due to lymphatic obstruction, are certain affections which resemble it in being caused, at least in part, by the lymphatics, but differ in being in the vast majority of cases congenital. It is not contended that they all exist at birth, though the greater number is already apparent then; merely that the conditions which give rise to them are dependent on some congenital defect, although they may only be called into activity later on by some additional cause.

In one form the increase in size is due almost entirely to the enormous dilatation of the serous spaces in the connective tissue or of the lymphatics, the partition walls between the expanded portions becoming thinner and thinner until they break down, and leave an irregular branching cavity extending among the deeper structures, to a distance of which the outside appearance gives no conception, lined with a delicate layer of endothelial cells, and filled with a clear serous fluid. These are most frequently seen in the region of the neck, where they are known as *congenital cystic tumours*, or as *hydroceles*. (*See* article on the Neck). In the latter there is no solid growth; they are simply clear-walled translucent cysts, often of large size, capable of being cured by incision, or by the injection of iodine. It is not advisable to make use of setons, as there is considerable danger, if suppuration sets in, of its becoming diffuse; and it must always be remembered that these growths are situated under the deep cervical fascia, and often have extensive deep communications.

Sometimes in the congenital cystic form there is a very considerable amount of solid growth, so as even to give rise to the suggestion of sarcoma, and they are not uncommonly polycystic and associated with nævoid growths of various characters. Iodine or incision is of little use in conditions such as these, and removal by dissection must always be regarded as a very serious measure; it must be complete to be successful, and it is rarely possible to tell beforehand where the blood-vessels and nerves lie, or how far they may be involved in the growth.

Hypertrophy of the tongue (*macroglossia*) and of the lip (*macrocheilia*) are of the same nature. They are congenital affections, though they are frequently not noticed until long after birth, probably caused by an obstruction to the lymphatics. As a result, the size increases enormously, owing in part to the distension of pre-existing lymph spaces, and the formation of new ones; in part to the over-growth of the submucous and intermuscular connective tissue. The muscular substance itself rarely participates. The increase in size may be so considerable as to cause serious deformity; the tongue is always getting in the way and suffering slight injuries, each of which excites a transient attack of inflammation. Every time this occurs, even if it is only slight, an enormous amount of swelling ensues, owing to the blocking of the lymphatics, and it never quite regains its former dimensions, always leaving a small but a permanent increase behind. The papillæ become enormously swollen, irregular in shape, and pale in colour; the surface of the mucous membrane is irregular, with here and there deep fissures running across it, perhaps the result of ulceration; the submucous tissue is perforated in all directions by a network of widely open channels, and the whole organ is infiltrated with innumerable white corpuscles, arranged in a kind of network so as to resemble lymphoid tissue.

Treatment.—For this there is nothing but excision; pressure can be tried, but it is only exceptionally that it can be applied with sufficient uniformity and for a sufficient time to produce any good result. Setons or other agents made use of for the purpose of causing absorption or consolidation of the growth, only make matters worse by the inflammation they excite. Sometimes improvement has followed the use of constitutional remedies, independent of any local treatment, especially when there has been a definitely marked diathesis; but this does not occur sufficiently often to deserve much reliance.

It is peculiar that this condition is sometimes associated with lymphatic distension in the neck (*lymphangioma*), and even with over-growth in other parts of the body; thus, as it were, forming a connecting link between cases of enlargement due definitely to lymphatic obstruction, and those peculiar instances in which all the tissues of a limb, including the bones and muscles, have grown after birth to an excessive size.

Other irregularities of growth, however, such as nævi and exostoses, are so often associated with this condition that it is not probable that obstruction is the only cause, though it may be an occasional one. The same may be said of that peculiar form of so-called hypertrophy of the breasts, due to an increase in the cellular tissue, whereby it becomes much looser and coarser in texture, which is so commonly met with in young girls at the time of the evolution of the mammary glands.

XXIX. INJURIES AND DISEASES OF NERVES.

HERBERT W. PAGE.

INJURIES.

Contusion, rupture, and wound of nerves. —The peripheral nerves are liable to the same sorts of accidents (contusions, ruptures, and wounds) as may befall other tissues of the body, but owing to their mobility and usually protected position in their course along the limbs, they enjoy a remarkable immunity from injury. The injuries which we have now to consider are, therefore, amongst the least common in surgery; but, nevertheless, they are amongst the most important, for they may give rise to consequences which are not only immediate, but to consequences also which may be remote both in time and situation. Contusions, compressions, ruptures, and wounds of nerves are all alike in this, that they may cause more or less impairment of motion and sensation in the parts to which the nerve goes. And by the presence of such symptoms, and by the history of the accident, a diagnosis can usually be made immediately or soon after the injury: immediately, when the nerve has been divided or severely contused; soon, when it has been only compressed or partially divided, and inflammatory exudation interferes with its function as a conductor of impressions. Were this all, the effects might be regarded as of comparatively small moment, for it might be hoped that when inflammatory products had been absorbed, or the nerve had re-united, motion and sensation would be regained, and recovery be complete.

Effects.—1. *Wallerian degeneration.* — Unfortunately, however, the section of a compound nerve, or any lesion which destroys its conductivity, leads to *degeneration* throughout its whole course beyond the seat of injury. This effect is due, it is believed, to the fibres being disconnected from their "trophic" centres, which, as Waller shewed, are the large cells of the anterior cornua in the case of efferent or motor fibres, and the ganglia of the posterior roots in the case of afferent or sensory fibres. This degeneration, which is now generally called *Wallerian*, occurs along the line of conductivity of the fibres, efferent or afferent as the case may be. When a posterior root, therefore, has been divided between the ganglion and the cord, degeneration spreads centripetally to the cord, and the posterior root wastes on the cord side of the lesion. Such a section can rarely, if ever, happen accidentally.

Division of a mixed nerve at any part of its course must separate its motor fibres beyond the point of lesion from their connection with the trophic cells in the cord, and Wallerian degeneration is the result.

Experimental observation has shown that the primary and essential changes of this degeneration "consist in the progressive destruction of the special elements of the nerve fibres, the medullary sheath and the axis cylinders" (Ross), and that they begin as early as the first day. The myelin breaks up into fragments and may ultimately disappear, and the sheaths of Schwann may in the end be filled with fine granules of fat and disintegrated globules of myelin. According to Ranvier, the axis cylinder disappears about the sixth day; by about the twentieth the sheaths of Schwann are more or less empty, and the trunk looks atrophied and shrunken, in varying degrees at different parts. The neurilemma also takes part in the process; it proliferates and leads to a cirrhotic condition of the nerve. Similar changes, though less in degree, arise also at the cut end, but only at the end, of the proximal part of the trunk.

If the nerve lesion is soon repaired, regeneration takes place in the degenerate fibres in the reverse order to that of the previous degeneration. The possibility and degree of ultimate restoration of function depend, to a large extent, on the length of time during which the nerve has been divided, for, in addition to degeneration in the nerve itself, changes are taking place in the muscles supplied by it. "The fibrillæ lose their distinct striation, and apparently undergo an alteration in their chemical composition. There is proliferation of nuclei, and of the connective tissue, leading also to a cirrhotic condition of the muscle" (De Watteville).

The consequence of these changes, which arise whenever the "trophic" influence of the cornual cells has been interfered with, whether by disease in themselves or in the motor cords which connect them with distant parts, is shown in marked alterations in the electro-excitability of the muscles, and what is known as the "*reaction of degeneration*" is established. The phenomena consist essentially in diminished, and soon annihilated, faradic excitability, with increase of the galvanic excitability, the response of the muscle to slow interruptions of the galvanic current showing various modifications according to the length of time that the degeneration has lasted. At first diminished, it gradually becomes increased as the excitability to the faradic current is disappearing, so that a smaller number of cells is sufficient to excite contraction than in a healthy muscle, and the contraction, moreover, is slow, lazy, and deliberate. Then, as degeneration advances, and becomes complete, and no muscular fibres remain, there is no longer response to either current, and the muscles may be looked upon as atrophied beyond all possibility of repair. Reaction of degeneration, it should be borne in mind, is essentially due to degenerative atrophy of muscle, which, we have seen, depends on a particular cause, and bears no relation whatever to paralysis. The muscles of a limb may be completely paralysed, for example, by cerebral lesion, but they need not on that account show any abnormality in electrical reaction.

2. *Loss of motion and sensation.*—While, however, the common early result of nerve division is loss of motion and sensation, the loss of sensation is often by no means as well marked as that of motion, even in cases where we know that a nerve has been completely divided. Thus, after division of the median in the fore-arm, the anæsthesia in the hand may not occupy the precise area of its known anatomical distribution. Variations of this kind are not at all uncommon, and are probably due to free communications between separate nerves at some parts of their course. This fact, which has been attested by numerous observations, must be remembered in forming a diagnosis, and in considering the advisability of any operation to rejoin a divided nerve.

3. *Trophic changes.* — Yet other consequences than those already named may follow severe nerve injuries or division, namely, disturbances of nutrition, often called "*trophic*," in the tissues at the periphery of the affected nerve. These "trophic" changes are most likely to arise when the nerve is being subjected to continuous irritation at the seat of lesion, as when its ends, perhaps only partially divided, are bound down in cicatricial tissue, or have been involved in inflammation at the time of healing of the flesh-wound. In such cases there is often the most exquisite tenderness at the cicatrix, tenderness so great, it may be, as to make the whole limb useless, and seriously affect

the patient's general health; and at the periphery of the nerve, say, in and about the fingers, there are grave nutritive disturbances. The part may be colder than natural, and may long remain so, be red or reddish-purple in colour, have on it blisters like pemphigus, or sores which have been started by some trifling injury and show little or no tendency to heal, and the nail may become crumpled and deformed, or be shed spontaneously. The fingers may be œdematous, glossy, eczematous, or erythematous in appearance; constantly moist with sweat, and perhaps extremely hyperæsthetic, and, as time goes on, they may become withered, parchment-like, and stiff. Whatever may be the immediate cause of these changes, whether they arise from vaso-motor disturbance, or be the direct result of some special "trophic" derangement, they are rarely met with unless the nerve at the seat of lesion is being subjected to continuous irritation, and they are commonly looked upon as signs of an "irritative" lesion.

4. *Changes in the central nervous system.*—Not only, however, may changes arise in the periphery of a nerve, but, in consequence of injury to a nerve trunk, it sometimes happens that certain changes or effects are produced in central parts of the nervous system. These are of two kinds: some arise immediately or soon after the injury, and are shown by palsy or spasmodic affections of parts not directly in relation with the nerve injured. They are probably reflex, purely functional in origin, and frequently pass away when the nerve lesion has been repaired. Whatever is their precise nature, they show at any rate how close an intimacy there is between the peripheral nerves and central parts of the nervous system. Nor is it strange that if functional disturbances should be thus generated, we should occasionally meet with cases where actual central lesion has been

thus set up in parts removed from the seat of peripheral injury. These form the second of the two forms of change. The explanation of such consequences may be difficult or impossible, but there is no question as to the fact; and in one of the most marked cases of the kind recorded by Dr. Ferrier, a morbid condition of the whole of the grey column of one side of the spinal cord was developed in connection with long-standing, peripheral irritation of nerve trunks in the stump of an amputated arm. All such cases, and all the manifold results of nerve lesion hitherto named, whether early or remote, teach the importance of placing an injured nerve in such a position that recovery and restoration of its function shall take place as soon as possible, and of preserving it from inflammation and irritation in the process of repair.

Nerve suturing.—By *nerve suture* the ends of a divided nerve can be put in such apposition that union will soon take place, and nerve degeneration and atrophy be reduced to a minimum. Nerve suture is either *immediate* or *secondary*. Immediate suture should be the invariable practice in all cases where a nerve has been divided in a wound, and the surgeon should no more neglect to look for and bring together the ends of a divided nerve, than he should to secure and tie the bleeding arteries.

The procedure is simplicity itself, and consists in bringing the ends into apposition, and fixing them together as accurately as possible by catgut or fine carbolised silk sutures passed either through the sheath alone, which is the best plan, or through sheath and trunk when the former is insufficient. The wound must be kept aseptic and suppuration prevented, and union of the nerve will soon take place, and the lost function will be gradually, and it may be perfectly restored. Sensation usually returns before motion.

Supposing, however, that primary suture has been neglected, that the nerve injury was unrecognised, or that suppuration and inflammation have led to the early bond of union being dissolved, and the nerve ends have become bound in irritative cicatricial tissue, that there is tenderness at the scar, and that "trophic" changes have been developed, then it may be desirable to perform secondary suture. This operation consists in cutting down upon the nerve at the seat of lesion, finding the ends, dissecting them free from the cicatricial tissue in which they are embedded, removing the bulbous nodules of fibrous tissue which usually involve them, and then uniting the clean-cut freshened ends as in primary suture. The size of the bulbous ends may be such that considerable shortening of the nerve is unavoidable after their removal. It may then be necessary to dissect the nerve free for some distance, so as to allow of its ends being brought more readily together, and the limb must be kept in such a position afterwards, at perfect rest, as shall minimise the traction upon them. The all-important thing is to avoid suppuration in the after-treatment, so that the nerve may not again be involved in a dense irregular cicatrix. Given, however, the avoidance of these things, there is every hope of considerable restoration of function even in cases where the condition has lasted for many months, and it is tolerably certain that the seat of lesion will cease to be painful, and that the trophic disturbances will disappear. The prognosis will largely depend on the state of the muscles, as learned by the character of the reaction of degeneration. Help in restoring muscular power and muscular nutrition may be gained by perseverance in electrical treatment.

Compression of nerves.—The same sorts of effects as those hitherto described may be due to pressure on a nerve trunk, by its involvement in inflammatory thickening, or by being itself inflamed. A man goes to sleep with his arm in such a position that his musculo-spiral nerve is subjected to pressure or exposure, or the same nerve may be injured in fracture of the humerus, either at the time by displacement of the bone, or later by the pressure of callus. Owing to its proximity to the humerus, this nerve is perhaps more often subjected to local injury than any other nerve in the body, and operative interference may be desirable when the resultant palsy of the extensors is slow in passing away, or is uninfluenced by other treatment. The precise seat of the lesion is often indicated by marked local tenderness of the nerve trunk, and this having been carefully noted, the surgeon must expose the trunk and release it from its abnormal surroundings. It may possibly be buried in callus or bone, out of which it must be carefully dissected. Even when no such serious causes of mischief are discoverable, the nerve trunk may yet be found a little swollen, red, and adherent, as in cases I have myself operated on, and its simple release may be the means of allowing restoration of function to be begun, or to be hastened when it had come to a standstill. Avoidance of suppuration by antiseptic precautions is here again essential to success.

NEURITIS.

Neuritis, or inflammation of a nerve trunk, is not a very common result of nerve injury, except to a very limited degree, when in association with inflammation in the immediate neighbourhood of it, the nerve likewise becomes inflamed, and is slightly red, swollen, and tender, as in the cases to which reference has already been made. Any wider extent of true neuritis is however uncommon from such a cause, for it is very questionable whether the degenerations of the myelin which follow nerve section are really due to inflammation. Indeed, the true nerve elements seem little prone to inflammation, and such inflammation as involves a nerve is rather limited to the connective tissue, and is a *perineuritis*, or *interstitial* neuritis, rather than a *parenchymatous* neuritis of the nerve elements themselves. Nevertheless, peripheral neuritis (so-called) is by no means uncommon in the course of various diseases, and may be independent, as far as present knowledge enables us to affirm, of any central or peripheral lesion such as causes Wallerian degeneration. All that can be affirmed at present is, that localised, spontaneous, non-traumatic, peripheral neuritis has apparent origin in such various conditions as cold, syphilis, lead poisoning, variola, diphtheria, typhus, and tuberculosis, and the toxic influence of chronic alcoholism, gout, and rheumatism. A patient with a gouty history or proclivities has tingling or other abnormalities of sensation perhaps, such as numbness or anæsthesia for a time in the course of a nerve or nerves. These are followed by severe pain throughout its periphery, and there may be extreme hyperæsthesia and burning sensation; the "causalgia" of Weir Mitchell. Degeneration of muscles may follow, and the reaction of degeneration be established. There may be every possible variety and degree in the severity of an attack. In the graver cases the resultant symptoms may suggest central lesion, and the diagnosis can only be rendered certain by carefully examining the electrical reaction. When of gouty, alcoholic, or syphilitic origin, such a neuritis is eminently amenable to treatment. Paralysis of the facial muscles from exposure to cold is also probably due to a neuritis of the facial nerve, and that also is most variable in degree, either passing away quickly, or leading to permanent degeneration of the nerve and muscles. Sometimes sensory nerves near the facial may likewise be affected, and then severe pain may accompany the motor palsy.

Peripheral neuritis has been found, moreover, in cases of tabes dorsalis, in cases of Pott's disease where there was pressure on the cord and consequent myelitis and bed-sores, and in cases where Charcot's "acute bed-sore" had arisen after hemiplegia, and also in herpes zoster. In these instances the nerve trunks found diseased were those which respectively ran to the anæsthetic areas in tabes, to the acute bed-sores, or to the district affected with the herpetic eruption. The main point of interest, however, is that the microscopical appearances, which resemble those found in Wallerian degeneration, and which consist in breaking up of the myelin into fragments, etc., may be of much more rapid development than is usual in that condition, the most marked alterations having been known to arise in the course of a few days. No continuous connection has been observed between the central nerve lesion and the peripheral disease, which is often most marked at the periphery, and gradually becomes less pronounced as the spinal cord is approached, and which thus seems to show a tendency to follow a centripetal march.

The naked-eye appearances of the affected nerves are frequently normal. All that can be said is that the central lesion somehow seems to predispose the nerve trunks to these inflammatory or degenerative changes, and possibly also, as has been suggested by Erb and de Watteville, there has been some simple dynamic disturbance of the spinal centres which has interfered with their normal trophic influence.

The symptoms of neuritis depend, of course, on the quality of the nerve affected, whether it be sensory, motor, or compound, as in the instances already given.

Multiple neuritis.—There is yet another form in which the "peripheral neuritis" is "multiple," involves many nerves, and in severest cases may cause almost universal sensory and motor paralysis, invading not only the nerves of the limbs, but also the facial nerves, special ocular nerves and the intercostals and phrenics, placing life in danger by interference with respiration or the action of the heart by implication of the vagus. Such a case of "multiple neuritis" may begin with pins and needles in an extremity, and may gradually go on till there is wide-spread paralysis of motion and sensation, with wasting of muscles, reaction of degeneration, "girdle pains" round the belly, and a tendency to bed-sores. The etiology of such cases is as yet not definitely known; but in some of the worst recorded cases a history of syphilis has been present, and the treatment usual for that disease has led to complete cure. There is every conceivable variety in the extent and degree of this kind of multiple neuritis. Chronic and excessive alcoholism is probably also a potent factor in its production, especially in cases where the neuritis chiefly, though not exclusively, involves the peripheral nerves of the legs. The extensors are the muscles chiefly affected, and "dorsal flexion" of the foot becomes impossible, so much so that the foot drops, and Dr. Buzzard regards "dropped feet" almost as pathognomonic of a neuritis due to alcohol as "dropped wrist" is of a neuritis due to lead. It is essentially the periphery of the nerves which is affected, and there may at first, and throughout the course of the attack, be excessive agonising pain and tenderness, not only of the skin, but of the muscles also when they are grasped in the hand. Cases of this form of paralysis are also most variable in degree. Death may follow, and no evidence whatever be found of disease in the spinal cord; while on the other hand the condition may pass away on abstaining from alcohol. Such a neuritis may give rise to symptoms strangely suggestive of tabes dorsalis, for there may be ataxy in gait, pains like lightning pains, and absence of knee-jerk; but while in tabes the electro-excitability of the muscles is normal, in peripheral neuritis there is wasting of muscles, and reaction of degeneration in various degrees. As the paralysis disappears, so the knee-jerk may return, a result which never happens when its absence is due to the posterior sclerosis of tabes. M. Déjérine has described cases of this kind, and has given them the name of "nervo-tabes périphérique" in contradistinction to that of "tabes médullaire," but the reader will do well to refer to Dr. Buzzard's recent Harveian lectures on "Certain forms of Paralysis due to Peripheral Neuritis," where he will find the fullest and most recent information on this extremely interesting and important subject. Knowledge of the apparently wide domain of peripheral neuritis is increasing day by day, and space alone forbids our entering into the subject in greater detail.

Neuralgia.

Neuralgia, or acute, violent, paroxysmal pain in the course of a sensory or compound nerve, is a symptom dependent on various manifold conditions, which may exist either in the course of the affected nerve itself or in some general constitutional disorder. It may be the result of some definite local injury, such as pressure on, or irritation of, the nerve trunk itself, or it may be "reflex," and involve some other branch of the same nerve, or, perhaps, of another nerve altogether. Such is the supra-orbital neuralgia, for example, dependent on the presence of a decayed tooth, or sciatica from sacro-iliac disease. In all cases, therefore, it is essential to try and discover some local, and, it is to be hoped, removable, cause for the neuralgic pain. More common, however, by far than neuralgia from discoverable local causes, and much less amenable to treatment, is neuralgia due to some general constitutional state, when it is impossible to say why pain should attack the special nerve affected. Neuralgia of this kind may perhaps be brought on by cold, and be more or less dependent on a neuritis; but there is usually some predisposing condition, some neurotic heredity, perhaps, which permits and perpetuates the pain. Anæmia and debility, however induced, are common conditions in those who suffer from neuralgia; as when an intercostal neuralgia, for example, afflicts a woman exhausted with child-bearing and long suckling, or a supra-orbital neuralgia arises in the course of neurasthenia of traumatic origin, such as is seen after the shock of a railway collision. The pathology of such conditions is quite unknown. In chronic cases it is not uncommon for tender points to be found in the course of the affected nerve at spots where it has just issued from a bony canal, or is becoming superficial after having passed through soft tissues. These may be due to a local neuritis.

In the course of a violent paroxysm well-marked nutritive disturbances may sometimes arise, such as local œdemas in the periphery; or there may be convulsive movements and increase of the natural secretions of the part, with alterations in the pigmentation of the skin and hair, phenomena indicative, it may be, of some definite structural change in the nerve, and not due merely to the functional condition, whatever that may be, which underlies the pain.

Treatment.—1. *Medical.* The indication in all such cases is to improve the general health and tone by good food and fresh air, helped with arsenic, first and foremost, and then quinine and iron, and not neglecting to treat such special conditions as gout and rheumatism. The local application of anodyne and stimulant liniments in the course of the nerve may give relief, and the subcutaneous injection of morphia in the neighbourhood of the nerve is sometimes beneficial, though the employment of these means is too likely to develop a craving for this drug. Considerable success has recently attended the practice of injecting a one per cent. solution of osmic acid into the tissues close to the affected nerve. The injection itself causes a good deal of local pain, puffiness, and swelling, and has to be repeated several times before any permanent subsidence of pain is produced. This is probably due to the fact that the osmic acid, which has a powerful affinity for certain elements of nerves, as is known by the staining which it causes, sets up degeneration in the nerve; for experiments on animals have shown that osmic acid stains a living nerve as readily as a dead one, and causes a parenchymatous degeneration of the nerve fibres with atrophy. The length of time which it takes to act in the treatment of neuralgia supports this view, and shows that the cessation of pain is not a "cure" in the true sense of the word. Acupuncture of the nerve has sometimes been found of service. The application of the continuous current, the positive electrode being placed over the seat of pain, occasionally gives almost instantaneous relief, especially when the neuralgia is independent of a local cause.

2. *Surgical.*—Still there are, unhappily, too many cases, such as those of neuralgia of one or more branches of the trigeminus, of "tic-douloureux," or neuralgia of the supra-orbital, where every kind of treatment proves useless, and it is necessary to consider whether any surgical procedure is likely to give relief. Hence have arisen the operations *neurotomy* and *neurectomy*, the one being a mere division of the

nerve, the other an actual resection of part of it. In either case the operation should be performed by cutting down on the nerve, exposing it without disturbance, and dividing it or removing a portion with scissors. The immediate effect is usually to annihilate the pain, but the reunion of the nerve makes this good result very often temporary, even when a considerable bit of nerve has been removed.

In the case of neuralgia of the second division of the fifth (the branch which is most frequently and severely affected), the pain is often so distracting and so ruinous to health that a section of it as it crosses the spheno-maxillary fossa has been several times adopted, the object being to divide the nerve before it gives off its branches to the teeth. Originally proposed by Carnochan, this operation has been performed in this country by Chavasse and others, the fossa being opened by trephining through the antrum, and the nerve thus reached as it courses from the foramen rotundum to the superior maxilla. In nearly all cases where it has been undertaken the whole of Meckel's ganglion has been removed, either unavoidably or intentionally, and although success has followed in some cases, it has done so by no means in all. Before undertaking it, it is essential to be quite clear that the neuralgia does really affect the posterior branches of the nerve, and does not simply involve the infra-orbital, which can easily be reached by a less formidable process. Of all neurotomies and neurectomies for neuralgia, it is impossible to say with certainty that they will bring more than temporary relief. Their frequent failure has, to some extent, led to the introduction of *nerve stretching* for the relief of various sensory and motor disturbances. This has been adopted in many cases of sciatica, and the lightning pains of tabes, and also of various spasmodic affections. One of the commonest and most distressing disturbances of this latter kind is that known as *tic convulsif*, where some or all of the muscles supplied by the facial nerve are subjected to incessant twitchings, which are liable to be aggravated by any movement of the body, which are sometimes associated with neuralgic pain or other functional disturbances in the domain of near sensory nerves, and which make life unbearable. The spasms may depend on some local cause affecting the facial itself, or some part of the nervous system, which may in some instances be got rid of; but in the majority of cases there is no obvious cause. For the relief of this condition the facial nerve has many times been stretched, after exposure as it issues from the stylo-mastoid foramen : and so also have cords of the brachial plexus for similar spasmodic affections of the arm. Space forbids any reference to all the kinds of cases in which nerve stretching has been adopted ; but, although it has had an extensive trial, it can hardly be allowed that it is really of greater permanent value than neurotomy or neurectomy. The immediate effect is usually paralysis of the parts supplied by the nerve, and relief from the pain or spasm, simply because stretching leads to disintegration of the nerve at the part stretched, and its continuity is thereby broken. In many instances there has been a return of the symptoms as soon as repair of the local injury has taken place. It is, however, a great thing in any case to give complete relief, if only for a few weeks, during which the general health may be restored, or the functional neurosis, or bad habit, so to say, of the nervous system to which the particular symptom was due, may be effectually broken, and there may, therefore, be no recurrence when the conductivity of the nerve is re-established. In no case is it possible to say beforehand that permanent relief is certain. How nerve stretching acts in successful cases it is impossible to say. When the symptom has been dependent on a local cause, stretching may release the nerve from embarrassing adhesions. In other cases a dynamic change is perhaps caused in the spinal ganglia, although experiments on the dead body have not made it by any means clear that any direct effect is produced on the cord itself when a spinal nerve has been even violently stretched.

It has been suggested that the relief given in neuralgia is due to disintegration of the "nervi nervorum" (Horsley), which ramify in the nerve sheaths, and which are more easily ruptured than the nerve tubules of the trunk itself. In performing the operation it is necessary to anæsthetise the patient, expose the nerve by incision directly over it, and subject it to a steady pull for about five minutes (Marshall), the force used being appropriate to the size of the nerve. The force may readily be measured by a dynamometer, and a pull of thirty to fifty pounds may be given to one of the largest trunks. The sciatic may be stretched very considerably without any definite operation by forcibly flexing the thigh on the pelvis while the leg is kept extended at the knee.

PERFORATING ULCER OF THE FOOT.

Perforating ulcer of the foot, or "mal perforant du pied;" is a special and peculiar form of sore which is found on the sole of the foot, most commonly under the metatarso-phalangeal joints of the big and little toes, one or both, and of one or both feet. The sore frequently has origin in the long-continued pressure of a corn, which leads to destruction and disintegration of tissue underneath it, until the joint becomes affected; and when, in course of time, an external opening is formed in the centre or immediate neighbourhood of the corn, there is found a sinus which leads directly to exposed and diseased bone. The mouth of the sinus is often small and surrounded by sprouting granulations and thickened, elevated, corn-like epidermis. There may be little evidence of active inflammation about it, and but a scanty discharge of poor, thin pus, and very often there is little or no pain, so that the patient hardly knows when the sinus is being probed. Healing of this sore, which varies much in character in different cases, may be sometimes induced by ordinary surgical methods, by ensuring relief from pressure, removal of diseased parts, subsidence of inflammation, and perfect rest. The local affection, on the other hand, may be so extensive as to call for removal of the toe, or of necrosed portions of the subjacent bones.

The local painlessness and anæsthesia are noticeable features in this malady, and coupled with them there is often anæsthesia of the neighbouring skin of the foot and lower part of the leg, with depression of temperature and a tendency to local sweating. There is usually no impairment of motor power. These concomitant phenomena have called attention to the peripheral nerves, in which considerable degeneration, of the nature already referred to in this article, has very frequently been found.

Perforating ulcer has also occasionally been met with in cases of tabes dorsalis, in which disease the peripheral nerves are often degenerate. This nerve degeneration has led some to believe that perforating ulcer is essentially a "trophic" change; while others, regarding the usual origin of the ulcer, look upon it as merely the result of pressure, quite independent of disease of the nerves. It is, of course, conceivable that the unrelieved pressure of a corn may set up the local condition seen in perforating ulcer, but this is not the usual result of corn pressure, a by no means uncommon ailment. The two opposing views referred to meet harmoniously in a third opinion which attributes the malady to the pressure of corns on structures whose vitality and nutrition are lowered, and which are, therefore, more vulnerable, because of their defective nerve supply. Peripheral nerve changes seem to be an essential part of the disease, and observations have shown that the degeneration affects not only the periphery of the nerves, but also, to a less extent, the trunk of the sciatic itself. That all cases of ulcer having the local qualities of perforating ulcer in the sole of the foot are of this nature it is by no means alleged. The precise diagnosis can only be arrived at by examination of the reflexes, and of the sensibility of the skin, and inquiry as to any history of previous sensory disturbance. Syphilis plays some part, perhaps, in the disease, but, at any rate, the treatment of this constitutional malady may have material influence in leading the sinus to heal, even though the state of the nerves be unaffected thereby.

Charcot's Joint Disease.

Charcot's joint disease is the name commonly given to certain remarkable affections of the joints which may arise in the course of tabes dorsalis ("locomotor ataxy"), and which Charcot, who first described them, considered to be "trophic" in origin, and due to degeneration in the spinal cord. No unanimous decision, however, has yet been arrived at as to the real nature of these joint changes, it being still a ground of dispute whether they are, or are not, directly dependent on disease of the nervous system.

The joints most commonly affected are the knee, the shoulder, the elbow, the hip, and the ankle, and very much less frequently those of the tarsus and metatarsus. A joint which has been affected shows, post-mortem, the following very remarkable appearances: disappearance of cartilage and wearing away of the ends of the bones, and, perhaps, of part of the adjoining shafts also; smoothness and polishing, not amounting to eburnation, of the ends of the bones; a tendency, more or less, according to the length of time since the joint was affected, and to its degree of mobility, to the formation of osteophytic processes both from the bones

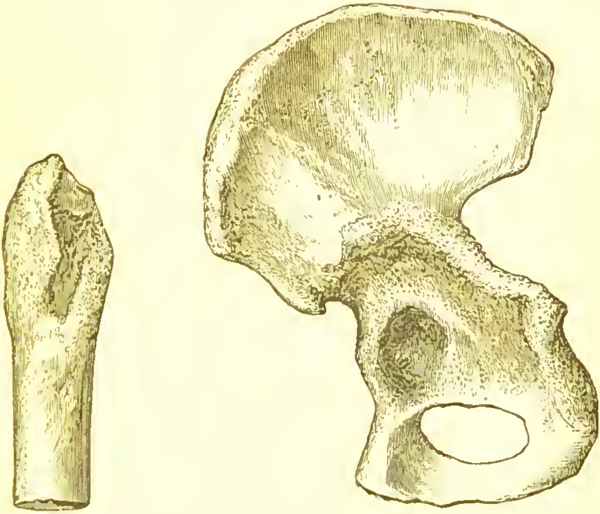

Fig. 28.—Head of Femur and Os Innominatum from a case of locomotor ataxy (Féré.)

themselves and in the ligamentous or muscular structures near; and thickening and pulpiness of the synovial membrane with a variable amount of fluid. The real nature of these pathological changes is not yet understood, but a rough resemblance which the bones of Charcot's joint disease bear to those of chronic rheumatoid arthritis, or arthritis deformans, have led some to the conclusion that the disease is neither more nor less than rheumatoid arthritis which has chanced to appear in a person suffering from tabes dorsalis, and the pathological changes of which have become excessive because the insensibility and painlessness, common attributes of Charcot's disease, had not led the patient to secure the needful rest for his limb, or because the uncontrolled and violent movements of ataxia had permitted inordinate friction of the ends of the bones upon each other, and so caused the extraordinary wearing away.

The clinical history, however, of these diseases is widely different, and seems to show that "Charcot's joint disease" is what Charcot thought, and still thinks, it to be, a disease *sui generis*, dependent directly upon, or somehow caused by, disease of some part of the nervous system. Without any injury, without warning, other than that given by increased lightning pains in the limb or other parts of the body, a patient suddenly finds that his knee or hip joint, for example, becomes swollen, he possibly wakes up with it in the morning; the swelling very rapidly increases, and perhaps there is effusion also in the soft parts adjoining, which become swollen and œdematous; the joint soon becomes unduly mobile, as if the ligaments and synovial membrane had been disorganised, the ends of the bones grate upon each other, and deformity or dislocation is readily induced. All this takes place without pain or sign of much inflammation, and free manipulation of the joint may cause the patient little or no discomfort. A storm seems to sweep down upon the joint and rapidly disorganise or destroy it, and if it could be examined soon after we should find it distended with fluid, the ligaments softened, the cartilages gone, and more or less of the epiphyses worn away.

The attack lasts for a few days and then subsides, leaving the joint misshapen and unduly mobile, and crepitus may be easily elicited. Months go by, and then, possibly, the joint is again attacked and further destruction caused, conservative processes having in the meantime been in progress by the formation of osteophytes, which, as in arthritis deformans, limit or prevent the movement of the joint, such as it now is. Or some other joint may be attacked in precisely the same way. Coupled with this joint disturbance there may be distinctive evidence that the patient has tabes dorsalis, and the diagnosis is comparatively easy, although it must of course be remembered that the subject of this disease may have an attack of simple rheumatoid arthritis; but it more often happens that the joint mischief of Charcot arises before the ataxia (that single symptom from which the disease had its original name of "locomotor ataxy") has appeared or become prominent. Inquiry, however, will most probably elicit that the man has suffered from lightning pains, the nature of which has hitherto perhaps been unrecognised, and examination reveals absence of knee-jerk, and, in many cases, also the "Argyll-Robertson symptom," in which the pupils do not react to the reflex stimulus of light, but yet contract normally on the accommodation of vision to near objects. Other evidences may then be gathered as to the existence of tabes dorsalis, such as a history of occasional diplopia, of temporary attacks of paresis of the bladder, of violent and inexplicable attacks of dyspepsia and vomiting, known as gastric crises, and attacks of violent palpitation; and we may also find anæsthetic patches in various parts of the skin, and delayed transmission of sensory impressions, and perhaps some atrophy of the optic nerves. There is abundant evidence, when looked for, that the patient is the subject of tabes dorsalis; but the important point is this, that the absence of that common symptom *ataxia* in movement, or what is known as the pre-ataxic stage of the disease, may divert all suspicion from the real nature of this joint attack.

In Charcot's disease of the tarsal bones and joints, known as the "*pied tabétique*," the phenomena are very much the same as in the larger joints. An attack is ushered in with increased lightning pains, the lower part of the leg and foot become enormously swollen and œdematous, and in a few days the bones of the tarsus are found to be freely movable on each other, and, as in a case under my own care, the foot may become like a mere bag of loose bones. The attack subsides, and the foot is left misshapen and deformed, shortened and widened, its arch obliterated, and the bones at length may be anchylosed together. A second and third attack may follow at long or short intervals, and lead to still further deformity.

As far as *treatment* can be of any avail, it should be directed to keeping the joint at rest, so that dislocation may be prevented. Any more active surgical interference should be avoided. Suppuration is uncommon, and as far as use of limb is concerned, the ultimate result will probably be far better than the once state of the joint would have appeared to render possible. Correct diagnosis is therefore of importance, that a limb may not be hastily condemned and amputated.

It is not by any means in tabes dorsalis alone that arthropathies are met with, although they are most striking in that disease. Joint effusions, both acute and subacute, with or without pain and inflammation, are met with, for example, in general paralysis, in hemiplegia of cerebral origin, and in other "system diseases" of the spinal cord, and Charcot has himself recorded a case where, after traumatic hemisection of the cord, effusion into the knee joint of the limb, which was paralysed as to motion, took place soon after the accident without any appreciable cause. In many cases of central nerve disease, bed-sores and cystitis are liable to arise. More special mention will be made of these conditions in the article on Injuries of the Spine, in vol. ii.; but it may here be said, that in all these various conditions, the most recent investigations have shown that peripheral nerve degeneration is very frequently present, and it may possibly be that the arthropathies of tabes are not less than the bed-sores of acute myelitis, the eruptions of herpes zoster, and the ulcers called "perforating," dependent on peripheral nerve degeneration, even though that has itself been determined by some lesion of the central ganglia. The peripheral nerves seem to play an important part, if not in the etiology, at any rate in causing the symptoms of various maladies, and their morbid changes are at this present moment engaging the serious interest and attention of pathologists, and throwing an altogether new light on many diseases of the nervous system.

TUMOURS OF NERVES.

Tumours of nerves are rare and do not often come under the notice of the surgeon. Nerve trunks are, nevertheless, liable to be the seat of tumours, which are called *neuromata*, although it would be more correct to apply this term to those only which are composed of nerve elements. These are very rare; by far the commonest kind of nerve tumours being those composed of fibrous tissue, the fibromata, or fibrous neuromata. They start from some part of the connective tissue of the nerve, may attain considerable size, and involve in great numbers the trunks of many nerves.

Sarcomata are not nearly as common as fibromata; they also spring from connective tissue.

From connective tissue spring also the *myxomata*, which are commoner than sarcomata, and appear as transparent lobulated nodules.

The position which the nerve trunk occupies in its relation to these various tumours depends largely on the precise point of origin of the growth, whether, for instance, it be at one side and the trunk is therefore stretched over it, or actually within the centre of the nerve, and the nerve fibres be spread out around it, or around the nerve, which therefore passes right through it. Tumours may be started by injury. Thus, and by the subsequent irritation, arise some of those bulbous swellings at the ends of nerves which have been divided accidentally or in amputation of a limb. These belong to the true neuromata, in which are *medullated* nerve fibres, although the greater part of them are formed of fibrous tissue. They may attain a large size.

The *non-medullated neuroma* rarely involves a nerve trunk.

Tumours of nerves, of whatever kind, are liable to be the cause of pain or muscular spasm, either from direct pressure, or because the nerve is stretched over them, but it is difficult to say in any case what is the precise relation of parts without actual inspection. The tumour may be near, not of, a nerve; but in cases of multiple tumours, the fact that they follow the course of a particular nerve or nerves makes the diagnosis of nerve tumours more certain.

When the general circumstances indicate it, and the position permits, it is well to remove a nerve tumour. Whether this can be done without excising a part of the nerve also must entirely depend on their relations to each other; but when a portion of nerve has been unavoidably taken away, the surgeon should endeavour to suture the divided ends, so as to ensure early union and the speedy re-establishment of conductivity.

XXX. SURGICAL AFFECTIONS OF THE SKIN.

MALCOLM MORRIS.

Clavus.—A corn is a localised hypertrophy of the epidermis. There are two varieties, *hard* and *soft*. They are both found on the feet, the former on the exposed parts, chiefly on the joints; the latter in the clefts between the toes. As hard corns are produced entirely by pressure, they may appear on almost any part of the body, and at times on unusual sites, as on the crest of the ilium from tight stays. The present absurd fashion of high-heeled boots throws the whole weight on the toes, which are in addition cramped to a point, thus producing severe corns. They differ much in appearance and shape. The hard corn is conical, and the apex of the cone pressing on the corium causes atrophy, and so forms a pit. The free surface is rough and hard. The soft corn is white and sodden, with often a deep fissure in its substance. The sodden appearance is due to constant maceration in sweat.

Both kinds of corn are exquisitely painful, though the pain varies in character from a dull aching to sudden stabbing. The hard is painful because of the pressure on the nerve endings in the papillæ and epidermis, and the soft from the depth of the fissures. Beneath a corn a small bursa may form, which may become the seat of an abscess.

The diagnosis is usually easy, though occasionally the extreme pain of multiple corns may simulate acute gout.

Treatment.—The treatment consists in removing all pressure and friction from the part, and then in removing the corn. When on the feet the boots should be wide enough to allow the toes to expand. Circular corn plaisters, with a hole in the centre, may be worn with advantage. When there is a bursa or an abscess formed, a prick with a knife will give great relief. In a severe case rest in bed is essential. A hard corn may be removed by means of curved scissors or a knife after soaking in hot water, or by the application of causties of various kinds, such as liq. potassæ, strong acetic acid, nitric or carbolic acids. Salicylic acid, either as a plaister or dissolved in collodion, is most useful. Soft corns should be converted into hard ones by separation of the toes with wool, by washing with equal parts of spirit and water, and free powdering with an antiseptie powder. They should then be removed.

Verruca.—A wart is an excrescence on the skin consisting of hypertrophied papillæ and epidermis. There are several varieties of warts described, the difference chiefly depending on their size and shape.

The *common wart*, or *verruca vulgaris*, is dry and horny. The surface, though usually worn smooth, is mapped out with minute cracks. By separating these it is seen that the wart is composed of numerous conical projections, the hypertrophied papillæ covered with thickened epidermis. The size varies from a small pin's head to that of a pea. Common warts appear most frequently on the hands and faee, especially in the young. They sometimes appear rapidly in crops, and as rapidly vanish; occasionally they are symmetrically distributed. The cause is unknown.

A variety is seen in elderly people, called by some *verruca senilis*, and by others *verruca plana*, because of their flat appearance. The anatomical structure is similar to the common wart, but it is larger, often as big as a thumb nail, smoother and flatter, and usually of a dirty brown colour. It is found scattered on the neck, back, and arms.

Occasionally very fine elongated warts are seen on the eyelids, the face, or the scalp. They grow to a greater length than common warts, and consist of a single papilla. They are sometimes called *verruca filiformis.* The most important variety of wart is that known as the *venereal wart*, or *verruca acuminata.* It sometimes assumes large dimensions and causes considerable pain. It may occur singly, or several warts may spring from adjacent portions of mucous membrane or skin, and, when grown, form together a large cauliflower mass. These masses occur on the genitals or near the anus in both sexes. Venereal warts are caused by the irritation of gonorrhœal or other foul discharge. They are not syphilitic in origin, but are local hypertrophies produced solely by local irritation. They emit a foul odour, from the decomposition of the discharges in their folds. The following distinctions separate the venereal wart from the condyloma. The former is an acuminate patch of papillary growth due to local irritation, and usually pedunculated; the latter is a flat-topped patch of papillary growth, due to syphilis, and never pedunculated.

Verruca necrogenica.—This may be regarded as a chronic form of anatomical tubercle. (*See* Art. XXXII., vol. i.) It is met with on the hands of those who are engaged in dissecting or post-mortem rooms, and occasionally on the hands of butchers and cooks. It is due to inoculation with decomposing animal matter. The affected part appears as a red thickened patch of chronically inflamed skin, covered with warty masses of dried epithelium. The skin is often cracked and fissured, and the affection is exceedingly chronic. Its duration is to be estimated by years.

Treatment.—Warts of all kinds can be removed by the knife or scissors. Single warts may be destroyed by various caustics, such as nitrate of silver, acid nitrate of mercury, nitric acid, etc. Soaking with strong acetic acid and then touching with nitrate of silver is often effective. Salicylic acid, used in various ways, is often very efficacious. A fine ligature applied to the base of a small wart will cause it to shrivel up and fall off.

Lupus vulgaris.—A chronic disease of the skin or mucous membranes, consisting of a cellular new growth in the corium, forming irregular yellowish nodules. It terminates in scars resulting from ulceration or atrophy.

Etiology.—It is more common on the continent of Europe than in Great Britain, and attacks females rather than males. It is a disease of early life, usually appearing between the second and tenth years, but is neither hereditary nor syphilitic. Until quite recently it was held to be a manifestation of scrofula, and its connection with the tubercular diathesis was pointed out by Mr. Hutchinson. Now the question, which still remains undecided is, whether it is a local tuberculosis of the skin or not. Schüller, Friedländer, Krause, and others, have found bacilli in lupous tissue, and Schüller has produced tuberculosis in animals by injection of lupous tissue into the trachea; but, on the other hand, Kaposi, Vidal, Cornil, and Leloir have obtained only negative results.

Symptoms.—Lupus first appears on the skin as a small light brown or amber-coloured patch about the size of a pin's head. This nodule retains its colour on pressure with the finger, though the redness around disappears; it has the semitransparent appearance and colour of "apple jelly." The patch may remain stationary for months or years, and then may disappear or may slowly enlarge; or several primary nodules may spread and coalesce, forming large irregular patches, the centres of which are gradually converted into scar tissue, while spreading at their circumference. The amount of destruction depends on the depth of skin affected. The subcutaneous tissues, muscles, cartilages, in fact, all tissues except bone, may be attacked. As a rule, there is no pain. The neighbouring glands are not usually affected, though there may be occasionally much erythema or œdema.

Lupus exedens, or *exulcerans*, are terms applied to the disease when there is distinct ulceration; usually this occurs on the nose or cheeks; lupus *non-exedens* when there is no ulceration. When the nodules shrivel and disappear without ulceration, but with desquamation, it is lupus *exfoliaceus*. Lupus *hypertrophicus* or *tuberculatus* is applied to projecting collections of lupus nodules, lupus *serpiginosus* to irregular patches formed by the fusion of two or more smaller ones. Lupus *disseminatus* describes the appearance of small, scattered, isolated nodules, while a last name is lupus *verrucosus* (McCall Anderson), or *scléreux* (Vidal), given to a variety with warty growths on the tubercles.

Next to the nose, the cheeks are most frequently attacked, then the extremities. Ears, mouth, gums, pharynx and larynx, eye, and female genitals, are next in order. The scalp is seldom attacked primarily.

Lupus of the nose.—At first, in most cases, one or more small yellowish-red spots appear on the skin near the tip or at the sides of the nose. They have to be distinguished from eczema and psoriasis, and from scrofulous tubercles, also from acne vulgaris, acne rosacea, and secondary syphilis. The age of the patient is important. The nodules are distinguished from eczema by the absence of moisture and persistence, and from psoriasis by the immunity of other parts of the body and the absence of silvery scales. Scrofulous nodules are harder, paler, and more raised than those of lupus. They are usually more rapid in growth, tend to ulcerate more quickly, and involve the lymphatics as a rule. The lupus nodules are usually larger than acne vulgaris spots, not limited to sebaceous glands, not pustular, are soft when pricked, and are of longer standing. They are distinguished from syphilis by the absence of constitutional symptoms and the mixed eruptions. The apple-jelly nodules and the scarring distinguish this from acne rosacea.

Lupus of the cheeks is a more symmetrical disease. A single patch that has lasted for years may not uncommonly be seen on one cheek; or scattered nodules on nose or cheek may extend and cover both checks.

However much the disease may extend, the forehead and chin, as a rule, are not attacked. In addition to scrofulo-derma and the other affections before mentioned, lupus has to be diagnosed from tertiary tubercular syphilide; the age, rate of growth, shape and colour of the patches, and presence of old scars, decide this. When attacking both cheeks and nose, and not ulcerating, lupus vulgaris may be confounded with lupus erythematosus; this is distinguished by the age at which it appears, by its symmetrical distribution and superficial character, by the absence of apple-jelly nodules and the character of the scar.

Acne lupus is a variety of lupus occasionally seen on the face, which often ulcerates, leaving small pits.

Chronic ulcerating lupus of the face presents an ulcer with ill-defined edges surrounded with lupus nodules. The discharge is yellowish, but not offensive, forming thick scabs, and there is a tendency to heal in the centre. The rate of growth is faster than in rodent ulcer or epithelium, and ulceration starts from several points at the same time.

Lupus of the face may produce most terrible deformity by destruction of the skin and scar contraction. Ectropion and dragging of the mouth and nose are common results, as also loss of a great portion of the nose.

Lupus may commence *on the ear* or extend from the face. It may begin on the membrana tympani or spread to the membrane from the outer ear, deafness frequently resulting. The destruction and deformity may be very great; the external meatus may be permanently closed.

Lupus may attack any part of the *trunk* or *extremities*, varying in appearance according to the part attacked. As a rule the process is slower than on the face. A variety called *lupus mutilans* attacks the fingers and toes, causing much deformity.

Lupus of the *mucous membrane* is difficult to recognise when the skin is not involved. The nasal mucous membrane is most commonly attacked, next the mouth and pharynx, and occasionally the larynx. Lupus of the genitals is very rare, in fact, almost unknown.

In the nose the first indication is the formation of a scab and a sensation of soreness. The surface beneath the scab is soft, sensitive, and bleeds easily. Deep ulceration may ensue if its progress is not arrested.

Morbid anatomy of lupus.—The microscope shows, in the fibrous connective tissue beneath the skin, scattered collections of young cells situated in a very vascular network. The growth extends along the vessels or the sweat glands, or the hair follicles and sebaceous glands, until the whole depth of the corsum is affected.

The epidermis, at first unaffected, becomes hypertrophied. Degeneration and absorption may take place in the deeper nodules without destruction of the epidermis; or ulceration of the whole substance of the skin, followed by cicatrisation, may result.

Treatment of lupus.—A. *Local.* When there is much erythema or œdema around the patch, soothing or astringent applications, such as lead or zinc, should precede surgical treatment.

The means of destruction are: 1, Mechanical; 2, chemical.

1. Free scarification is effectual when the disease is on the face and superficial. When the parts are more deeply affected and in all forms of ulcerating lupus, and in lupus of the mucous membranes, scraping by means of a blunt spoon is to be preferred. It must be done thoroughly and repeated constantly.

The actual cautery at times gives excellent results, but the resulting scar is not so satisfactory as that following scraping, as much thick cicatricial tissue is formed. Combination of cautery, either Paquelin or the galvano-cautery, with other methods, is occasionally useful.

2. The chemical method is almost obsolete, owing to the difficulty in regulating the action of caustics. Nitric acid may destroy too much, weaker caustics may destroy too little, and stimulate the remaining growth to renewed action. Of the various caustics, acid nitrate of mercury, or the solid stick of nitrate of silver, are the best. Arsenical paste was formerly much used.

B. *Constitutional.*—Lupus usually occurs in healthy people, but if there is any deviation from health it should receive attention. Iodine, phosphorus, arsenic, cod-liver oil, are advised by some, but the chance of cure is remote, if not impossible, without active local treatment.

Lupus erythematosus.—*Definition.* A hyperæmia of the skin with cell growth mainly affecting the sebaceous glands and hair follicles.

Etiology.—The cause is still obscure. Females are more liable to its attack than males. It is neither hereditary nor contagious. It is not syphilitic.

Symptoms.—The disease usually begins between fifteen and thirty, and often lasts for life. It commences with one or more well-defined erythematous patches on the face, usually primarily on the nose, spreading and coalescing to form the "butterfly" outline. It is always symmetrical, and may affect any part of the body; the cheeks, first one and then the other, being affected after the nose; then extending to the ears, scalp, backs of hands and fingers, feet and toes, and trunk.

The colour is bright or dull brick-red or violet in tint. A grey, often yellow, crust forms on the patch, adhering to the skin by plugs of sebaceous matter which extend into the follicles, and when removed leaves a red and pitted surface with bleeding points. As the patches spread, silvery thin superficial scars are left in the centre. The spreading edge is raised, the centre depressed. The scar, when on the face, causes great deformity by its contraction, but there is never any ulceration, atrophy being the termination. The general health is usually not affected, except in a rare severe variety, described by Hebra, in which death resulted. Some burning or smarting on exposure is experienced, but there is little or no pain.

In an early stage it has to be diagnosed from simple erythema, which is a transitory affection. From eczema it is distinguished by the absence of watery exudation, by its chronic course, and later by the presence of scars; from acne rosacea by its well-defined and raised margin and by the absence of pustules and tubercles. The syphilitic eruption simulating lupus erythematosus is a late manifestation, more rapid in its course, and is relieved by antisyphilitic drugs.

Morbid anatomy.—At first there is a dilatation of the capillary plexuses of the sebaceous glands and hair follicles, followed by gradual development of a small-celled growth in the surrounding connective tissue. The crusts are formed of sebaceous matter. The sweat glands are primarily affected according to some.

Treatment. — A. *Local.* The indications are: 1. To allay smarting and burning, by soothing and astringent applications. 2. To promote absorption by stimulating applications. 3. To destroy the growth by mechanical or chemical means.

1. Removal of sources of irritation, such as sun, cold wind, sea-air, is very beneficial in early stages, also the use of ointments or lotions containing liq. plumbi, calamine, oleate of zinc, or liq. carbonis detergens. All crusts should be removed, best by a mixture of equal parts of soft soap and spirits of wine. 2. Mercurial ointments, sulphur, chromic acid, iodine, carbolic acid, etc., are of use in individual cases. 3. The best method of destruction of the growth is multiple linear scarification, repeated at intervals of a week, for a long period. Other methods are electrolysis, cautery, scraping with sharp spoon, or application of caustics, such as Vienna paste, or acid nitrate of mercury.

B. *Constitutional.*—Benefit in some cases has been said to result from the use of either arsenic, iodide of potassium, cod-liver oil, or phosphorus.

Chilblain.—A chilblain is a localised dermatitis, produced by cold and damp. It is more often met with in females than in males, and occurs with especial frequency in children who have a weak circulation, or are anæmic. The parts attacked are generally the toes and fingers, but occasionally the nose and ears. There is at first an erythematous blush, sharply limited in outline towards the trunk, which disappears on pressure. This congestion causes burning, and often much itching, which comes on in paroxysms, After a variable time the skin may gradually recover its usual colour. If this does not occur, the part becomes more swollen and painful, and of a dark purplish hue, and subsequently vesicles or pustules may form. When these burst, raw tender surfaces are left, which is the stage of the disease known as "broken chilblain." From extreme and persistent cold and from neglect, gangrene may set in, and the condition pass on to that known as "frost-bite.

Treatment.—In the erythematous stage much relief is experienced from evaporating lotions. Painting with iodine is also useful. For a quick recovery, rest in the horizontal position is essential, as well as the avoidance of damp and cold. In the "broken" stage, the part may be treated on the dry plan, which consists in powdering with oxide of zinc, thymol, and starch, surrounding the toes individually, and the foot, with wool, and keeping the limb elevated. Subsequently boric acid ointment, or a mild mercurial, will be suitable applications. As chilblains occur in people with bad circulation, every effort should be made to improve it, and prevent the occurrence, by exercise, warm clothing, and nourishing but not stimulating diet. Hands, feet, and face, should always be washed with hot water, and not cold.

Boils.—A boil is a small localised inflammation of the cutaneous tissues, usually passing on to gangrene, and terminating by the discharge of the dead part as a slough, and subsequent granulation.

Boils are commonly situated in the neighbourhood of one of the glands or follicles of the skin. Most frequently they have their seat in the connective tissue surrounding a hair follicle, and the hair may be seen piercing them; but they may also attack the sebaceous, sweat, ceruminous, or the meibomean glands. They occur usually on the face, the neck, the back, or on the buttocks.

Etiology.—Boils are found at all ages, but are most common during adolescence. They are predisposed to by sudden changes of habit, as in a course of athletic training, by a too animalised diet, by sea-bathing, by want of personal cleanliness, and by cachectic states. They are common in diabetics, and persons suffering from albuminuria. Boils occasionally show a tendency to occur in epidemics, and in the spring time. The exciting cause is frequently some local irritation, such as friction and chafing, or irritating applications, poultices, etc.

Signs.—A boil begins as a small hard red papule, which itches, and is the seat of throbbing pain, and is also very tender to the touch. The papule soon shows on its surface a vesicle, or a pustule, which bursts, leaving exposed a greyish slough, surrounded by suppurating tissue. After a time the slough softens, loosens, and is finally discharged, after which the surrounding inflamed surfaces throw up granulations, which rapidly cicatrise and heal the wound. The slough discharges by a single opening, and the boil does not spread to the neighbouring tissues when once the slough has formed. The lymphatic glands in the neighbourhood become enlarged and painful.

Sometimes there is no slough, but the papule is very hard and extremely tender, and undergoes resolution without suppuration. This goes by the name of a "blind" boil.

Boils rarely appear singly, but usually in successive crops. A certain amount of constitutional disturbance accompanies an outbreak, but usually this is not very great.

Pathology.—The discharged slough has occasionally been found to contain portions of the hair follicle or the gland in which the boil originated. It has been thought that the slough is due to thrombosis of the vessels supplying the part affected, and in consequence of this a gangrene of the tissues follows. Some observers, again, have found various organisms in the tissues attacked, and have thought that these were the cause of the inflammation.

Treatment.—The progress of a boil may be checked in the early stages by the use of strong counter-irritants, such as carbolic acid, nitrate of silver, or saturated solution of perchloride of mercury to the parts affected, or by injecting concentrated carbolic acid into the papule. Later on water-dressing or poultices should be applied, or the boil should be smeared with glycerine and belladonna. The application of boric acid lotion or the painting of the circumference of the boil with collodion is recommended. The pain may be relieved by the application of a very hot sponge.

At the same time the constitutional causes require treatment. The hygienic surroundings should be remedied, and the diet regulated. If there is a cachectic state of the system, tonics will be necessary. Arsenic, phosphorus, and iron are of use to prevent further crops appearing, and sulphide of calcium (one-tenth of a grain every two hours) is recommended by Ringer to hasten the separation of the slough.

Carbuncle.—Carbuncle is also a form of gangrenous inflammation of the cutaneous tissues; but it is larger than a boil, shows a greater tendency to spread to the surrounding parts, and is accompanied by more severe constitutional disturbance.

Etiology.—Carbuncle is nearly always associated with a deteriorated state of the general health. Many of the causes of boils mentioned above also tend to produce carbuncle; but the latter affection is more common in old people, and in men, and is specially prone to occur in diabetes.

Signs.—Carbuncle is most common on the posterior surface of the body. It begins somewhat like a boil, but the area affected is much larger and is of a deeper red in colour. The pain is very great and of a throbbing character. After a time several openings form, through which the slough is seen, and round them there is a hard brawny swelling of a dark red colour. Soon the various openings coalesce, revealing a large grey slough, bathed in pus and surrounded by inflamed tissue. The slough softens and is finally discharged, but during this time the carbuncle is spreading at its hard border, and the slough is perhaps extending beneath the edges of the opening, and may attack the muscles and deeper structures. However, when the slough separates the inflammation usually ceases to spread, granulation occurs, and the wound heals. A carbuncle generally occurs singly, but for some time afterwards boils are prone to appear in the neighbourhood, caused not uncommonly by the applications to the carbuncle.

The constitutional symptoms are sometimes very severe. There is a general febrile state, which in severe cases tends to a low type, and may end in the typhoid condition, or death may ensue from simple exhaustion. Sometimes true septicæmia or pyæmia may supervene, especially when the face is attacked.

Treatment.—The constitutional treatment is most important. The bowels should be first cleared out. If the patient is very debilitated, iron and quinine should be given. Stimulants will nearly always be necessary in the form of alcohol, and as ammonia and bark. The diet, too, should be as nourishing as possible. To relieve pain opium may be necessary.

As recommended for boils, a carbuncle may be treated in the early stages by counter-irritants to stop its course, if possible. Afterwards the part may be tightly strapped with soap plaister. If the inflammation is still severe, then water dressing is necessary, and is preferable to a poultice. The old treatment of incision should be avoided if possible ; but if there is great pain and tension of the parts, a crucial incision will give relief. After separation of the slough, antiseptic and stimulant lotions are desirable, to promote healing. The best are boric and carbolic acid lotions. Iodoform also is of great use, and an ointment of friar's balsam will hasten cicatrisation.

Onychia.—An inflammation of the matrix of the nail, which may arise from a variety of causes. The commonest is direct injury, others being chronic eczema, psoriasis, ringworm, syphilis, leprosy, and struma. The earliest symptom is swelling, which produces considerable pain from pent-up fluid beneath the nail. By degrees the nail becomes detached at the sides, and exposes a raw ulcerating surface. The nail itself becomes thin and dark in colour. In some severe cases, probably strumous in origin, the ulceration assumes a malignant type, and is called *onychia maligna*. The discharge is foul and the ulcerations are deep and ragged. There is little tendency to repair, and the case often terminates in total destruction of the distal phalanx. The same term has also been applied to epithelioma involving the nail matrix.

There is a variety of onychia which must be specially mentioned, called *paronychia*, or more commonly known as "*in-growing toe-nail.*"

This affection may be hereditary. It usually attacks the great toe. The nail becomes hypertrophied and grows laterally. The result is, that from pressure of the boot the sharp angle penetrates the soft fold of the skin, and, by constant irritation, produces an ulceration the granulations of which often rise to a great extent and overlap the nail. The pain is most acute when the side of the toe is touched.

There is another variety of onychia which is syphilitic in origin.

Treatment.—In the early stage of onychia, when there is much effusion of fluid beneath the nail, much relief can be given by division of the nail. When, however, the nail is disorganised and there is much ulceration beneath, every particle of the nail should be removed. The ulceration should be dressed with finely-powdered iodoform and coffee, equal parts, or with nitrate of lead. Constitutional treatment is essential in the strumous form of the disease.

"In-growing toe-nail" should not be removed, as is the usual custom, until other and less barbarous methods have been tried. Scraping the centre of the nail thin with glass is useful, but the most effective plan is to pass a delicate layer of tinfoil between the sharp angle and the ulcerating surface, to be kept in place by narrow strips of plaister. Boots and shoes must be made sufficiently wide at the toes to prevent lateral pressure. The ulceration should be dressed as in onychia.

XXXI. SCURVY.

MALCOLM MORRIS.

SCURVY is a peculiar constitutional disorder, accompanied by profound blood changes, and due to abnormalities of diet which are as yet little understood.

Etiology.—Scurvy is most frequently met with among sailors, who make long voyages with few opportunities of varying their diet. It has been attributed by different observers to the exclusive use of a salt diet, or of decomposing food, or to bad water; but the most constant of its etiological factors is the absence of fresh vegetables from the diet. Other conditions seem to have at least a predisposing influence. Thus, cold and damp weather, bad hygienic surroundings, over-exertion, general deficiency of food, as in times of famine, and privation of all kinds, all assist in the production of the disease. A combination of these causes has rendered scurvy particularly prevalent and virulent in the various arctic expeditions. Psychical depression is said to be a predisposing cause, but it will be seen below that this is really one of the first signs of the disorder. Scurvy occurs endemically and epidemically in armies engaged in the field, in besieged cities, in prisons and barracks. These land epidemics seem to be prevalent more especially in spring, and are most common in cold zones, especially in northern Europe. They occur in every country, but have shown themselves most frequently in Russia, Germany, and Norway.

The absence of fresh vegetables from the diet is, however, not an invariable cause of the disease; and it has been suggested recently, on account of its epidemic and endemic outbreaks, and the general inconstancy of its causes, that scurvy is a miasmatic infectious disease. It has also been proposed that an infectious scurvy should be separated from the ordinary form. An old view, that scurvy is a contagious affection, has also been recently revived, but on insufficient grounds. It is evident that in the endemic and epidemic outbreaks, and in the cases of supposed communication by contagion, the same hygienic and dietetic conditions which may cause one may also affect all the other individuals in the same district.

Sporadic cases of scurvy are met with occasionally in the land population of Great Britain, and are usually traceable to general privation, or to a voluntary abstinence from vegetable diet.

In infants a deficiency of milk in the diet will produce scorbutic symptoms.

The **symptoms** of scurvy commence gradually. Before the characteristic signs appear the patient is depressed in spirits, and complains of weakness, general malaise, and of pains in the joints and limbs simulating rheumatic pain. When the disease is fully developed the complexion is sallow and earthy, the face puffy, especially beneath the eyes, and the conjunctivæ are pearly white. The skin is dry and harsh, and frequently desquamates, especially over the legs. A little œdema may be observed at the ankles. Numerous petechiæ of various size are observed in the skin. These are most numerous over the legs, but may be found in any part of the body, and commonly surround the hair follicles. Other eruptions are also occasionally seen, such as erythematous maculæ, papules which are sometimes associated with cutaneous hæmorrhages, pustules and vesicles, some of which contain merely a serous fluid, but others have bloody contents (scorbutic pemphigus).

The vesicles may burst, leaving an ulcer over which a scab may form, the ulceration extending beneath it. A very serious form of ulceration is found in severe cases of scurvy, and occurs as the result of injury, or after suppuration of the deep-seated effusions to be presently described, or in the cicatrix of an old ulcer which has been healed. It may also occur without any apparent local cause.

The *scorbutic ulcer* is usually situated on the legs, and varies in size, sometimes being of very considerable superficial extent. Its surface is livid, covered by dark red granulations, and discharges a thin dirty grey or sanious, foul-smelling secretion. The border is thick, hard, and shining, and surrounded by a blueish-red rim of from half to one inch in extent. The ulcer spreads very rapidly to the neighbouring soft strictures, and may extend so deeply as even to expose the bones. Its fungous granulations are prone to bleed very easily, and serious hæmorrhage may sometimes ensue from erosion of a large vascular trunk. The ulceration is also very slow to heal; old ulcers may assume the above type when the patient becomes affected by scurvy.

A marked feature of the disease is the formation of *hard swellings* in various parts of the body, but more particularly in the popliteal space, in the calf and tibial muscles, in the bend of the elbow, and occasionally behind the angle of the jaw. The skin over them may be normal, or may show the usual colours of a fading ecchymosis. The swellings themselves are hard, but on firm pressure may be made to pit slightly. They are painful to the touch, and when on the flexure of a joint render all movements of the joint painful also, and may cause a false anchylosis of the articulation. The knee joint is sometimes fixed in a position of flexion by a large swelling in the popliteal space. The swellings may also form on the front of the tibia between the periosteum and the bone, simulating a syphilitic node. They are due to hæmorrhage and fibrinous effusion in the muscles and other deep structures. Sometimes they suppurate, and on the site of the abscess the scorbutic ulcer may form.

It has been mentioned that pain in the joints may occur as an early symptom. Later on in the disease the joints may be swollen from serous or sometimes hæmorrhagic effusion into the cavity of the articulation. In severe cases effusion of blood has been observed at the costo-chondroid articulations, separating the ribs from their cartilages; in some cases, too, the callus round a united fracture has become absorbed, and the fragments reloosened.

A most characteristic condition is *the affection of the gums*, which is found in a large majority of the cases. The gum, where it is in immediate contact with the teeth, becomes swollen, painful, of a dusky red or blueish-red colour. The swelling may increase so much as to completely hide the teeth. The gum bleeds on the least irritation, while in severe cases the ulceration occurs, and grey sloughs are formed. The teeth may drop out, and portions of the jaw may even necrose. The breath at the same time is very fœtid, from the presence of the ulcerations in the mouth. The gum change was formerly looked upon as a constant sign, but it is now known to be occasionally absent. In one epidemic of 116 cases, the gum change was absent in twenty-six cases; but this is too high a proportion for ordinary cases. It is never found where the teeth are absent.

The lips are pale; so also is the mucous membrane of the mouth, and the latter may present a cyanotic appearance with scattered petechiæ. A swelling of the posterior wall of the pharynx has been described in some cases (angina scorbutica).

The appetite is good throughout the disease. The tongue is pale, clean, and flabby. The bowels are usually at first constipated, but in the later stages diarrhœa may occur, the stools sometimes containing blood. The spleen is, in severe cases, increased somewhat in size.

The urine is scanty, and rich in pigment. It contains a less amount of potash salts than normal urine, and urea and phosphates are also diminished ; albumen may be present.

The pulse is sometimes, in severe cases, very slow, sometimes quickened. Syncope is prone to occur, when the patient suddenly assumes the upright position. The breathing is rapid, but examination of the chest reveals no abnormal condition. The temperature is usually normal.

The patient is peculiarly apathetic and drowsy. The intellect is, however, usually clear, but occasionally delirium may be present.

We find occasionally hæmorrhage in the conjunctiva and in the anterior chambers of the eye. In a few cases hæmorrhagic choroiditis, and panophthalmitis have been seen. Themeralopia is sometimes associated with scurvy.

Complications.—The main complications are of a hæmorrhagic nature. Thus we may have epistaxis, hæmatemesis, hæmoptysis, melæna, hæmaturia, and hæmoglobinuria. Inflammation and hæmorrhagic effusions in the pleura and pericardia are also found in some cases. Pneumonia is frequently observed in severe cases. Symptoms of hæmorrhage into the spinal cord have been noted. Scurvy in many cases is complicated by the presence of dysentery, malaria, or syphilis, and is then much increased in severity.

Pathological anatomy.—The blood shows a deficient alkalinity, an increase of fibrine, and a diminution of the potash salts. The red corpuscles are fewer than normal. A hyaline degeneration of the eapillaries has been found. Hæmorrhagie or fibrinous effusions are found separating the museular fibres or in the planes of eonnective tissue. Eeehymoses are seen on the surfaee of the lungs, in the alimentary eanal, and on other mucous surfaccs. In the intcstines ulcerations are found, and frequently the lesions of dysentery.

Dr. Garrod advaneed the view that seurvy was due to the diminution of the potash salts in the ingesta and in the blood; but seurvy has bcen produeed by a diet rieh in potash salts; and beef-tea, whieh eontains large quantities of potash salts, is not of much avail in treating the disease. It has also been thought due to a diminution of the organie salts in the food, but potatoes, whieh are peculiarly antiseorbutie, contain but a small amonnt of organic salts. Aceording to Dr. Ralfe, thc disease is eaused by a diminished alkalinity of the blood, from either an increase of neutral salts at the expense of the alkaline, or from absolute deerease of the alkaline ones. Similar symptoms arc produeed by artifieially aeidifying the blood of animals.

Diagnosis.—Seurvy may be eonfounded with purpura, but the presence of the earthy complexion, the hard, brawny swellings in the limbs, the ehanges in the gums, and the history of the preceding eonditions, will at once distinguish it.

The pain in the joints may oeeasionally be mistaken for rheumatism, still more so if it be remembered that rhenmatism is sometimes aecompanied by eeehymoses beneath the skin (peliosis rheumatiea), and that seurvy may occasionally show a rise of temperature. The eondition of the gums, however, and the brawny swellings in thc museles, together with the history, will bc suffieient to determine the diagnosis.

The seorbutie uleer may be distinguished by its peculiar characters described above, and by the presence of the other signs of the disorder.

A peculiar disease has been described in this country by Dr. Barlow under the name of **infantile scurvy.** It occurs in young children, and seems to have some relation both to rickets and scurvy; indeed, in Germany it has become known as "acute rickets." Swellings are found in connection with the bones, most commonly the femora, and usually marked at the ends of the shafts. The epiphyses are sometimes separated. The bones are extremely tender, and hence the limbs are held motionless. Some œdema of the limbs may be seen. The gums are in many cases spongy, anæmia develops, and various hæmorrhages occur. There is usually a slight febrile temperature. The pain and swelling have been found, on post-mortem examination, to be due to extravasation of blood between the periosteum and the bone. The disease is due to a deficiency of milk in the diet of infants, and of vegetables in that of older children.

Treatment.—Rest in bed must be strictly enjoined, to avoid a fatal syncope. Dietetics form the most important part of the treatment. Fresh vegetables, such as potatoes, cabbage, cauliflower, should be given. The graminaceæ and the leguminosæ, such as peas, are of no avail as antiscorbutic remedies. Milk also is useful, especially in the infantile form. The diet must, in addition to the above alterations, be rendered as nourishing as possible by the administration of beef jellies, chicken broth, etc., and meat should be given as soon as the condition of the gums will permit of mastication. Malt liquors are of service, and spirits should be prescribed when signs of failure of the heart are observed. Internally, the citrate of potash should be given, and lemon or lime-juice tonics, especially quinine and iron, are necessary, not only during the convalescence, but early in the disease. Local treatment is seldom necessary, for the various lesions usually heal rapidly when the diet is regulated. The ulceration of the mouth may be relieved by chlorinated washes or dilute Condy's fluid, and other complications treated as they arise.

As prophylactic treatment, ships' crews should be served out regularly with preserved vegetables, especially potatoes, and with lime-juice, as recommended by the Board of Trade.

XXXII. ANIMAL POISONS.

WILLIAM ANDERSON.

Dissecting-room wounds.—Wounds inflicted in the course of dissection usually heal readily, and without complication, but in certain cases may be associated with local inflammation, and with implication of the absorbents. (*See* Art. XXVIII., vol. i.) The condition known as "anatomical tubercle," which appears to be a result of chronic irritation of the unbroken skin by frequent contact with decomposing animal matter, consists of a warty thickening of the cuticle, and papillary layer of the derm, sometimes followed by a pustule or painful fissure, and occasionally associated with lymphangitis. The destruction of the part with nitrate of silver or other strong caustic is generally sufficient for a cure. (*See* Verruca negrogenica, Art. XXX., vol. i.)

"Post-mortem" wounds are liable to assume a gravity never incident upon dissecting-room injuries. In the majority of instances the cuts and abrasions contracted during an autopsy give rise to no bad symptoms. In other cases the sore may become more or less acutely inflamed and complicated with lymphangitis; various manifestations of digestive disorder, such as foul breath, nausea, and diarrhœa, and more or less febrile reaction. Finally, in a third and much smaller group may appear intense symptoms of blood poisoning, sometimes independent of any serious local signs, sometimes attended by diffuse phlegmon extending to the axilla and chest wall and even to the pleura; or gangrenous inflammation of the parts with sloughing of tendons and destruction of joints. The constitutional disturbance is of varying type, but nearly always adynamic. True pyæmia may also arise under the same circumstances.

It is probable that three or four distinct affections dependent upon the entrance of specific micro-organisms into the blood have been included under the common heading of "post-mortem wounds."

Treatment.—Every wound inflicted during a dissection or autopsy should at once be sucked until the blood flows freely, washed in a stream of running water, and then thoroughly cauterised with caustic potash or nitrate of silver. Should the injury escape notice until pain and inflammation set in, the wound must be incised if not sufficiently open, and the caustic applied as before. Lymphangitis, abscess, etc., may be treated according to the principles laid down in other portions of this work.

The constitutional treatment will be in great measure symptomatic, but as a rule it is advisable at the onset to act upon the bowels by a purgative, especially if there be signs of intestinal irritation, and to empty the stomach by an emetic where nausea or vomiting is present. Subsequently nourishing diet, tonics, and pure air must be relied upon as the most trustworthy means of restoring the strength.

Poisoned wounds, of a character very similar to those met with in dissecting room injuries, may arise from inoculation with various forms of decomposing organic matter, as the lye of mottled soap, rancid machinery oil, etc. Lymphangitis and glandular abscesses are not uncommon results, and must be treated as prescribed in Art. XXVIII.

Stings of bees and other invertebrate animals in this country seldom call for more than domestic treatment; but dangerous symptoms may arise when the points of attack are very numerous, or even from a single sting inflicted in the neighbourhood of the glottis.

In most cases of bee sting, the extraction of the piercing apparatus (the modified ovipositor of the sterile female) and the local use of a little vaseline or liquor ammoniæ will prove sufficient; but where there is serious prostration consequent upon a multitude of stings, diffusible and alcoholic stimulants should be administered in large doses, combined, if there be much pain, with chloral or opium. The application of cocaine may be recommended as a local anæsthetic.

The caudal weapon of the *scorpion*, and the mandibles of the larger *centipedes* and *spiders* of tropical and semitropical countries, may inflict serious and even fatal poisoned wounds, and it may be necessary to excise or cauterise the lesions, and to combat prostration by the free administration of stimulants.

Bites of venomous serpents.—The only poisonous snake in England is the common viper, the bite of which is seldom fatal to man.

A wound inflicted by the fangs of the viper is followed immediately by severe pain and rapid swelling of the injured part, accompanied in some cases by vesiculation and wide-spread discoloration of the integuments; and the local signs are attended by faintness, with nausea or vomiting, thirst, and sometimes diarrhœa and suppression of urine. The patient usually rallies, but the utility of the injured member may be impaired for many weeks by the infiltration of the cellular planes with extravasated blood and inflammatory products.

The bites of the thanatophidia of warmer countries are far more deadly in their results. The local manifestations are similar in kind to those already described, but far more intense, and the constitutional symptoms are those of profound shock, mental and physical, commonly associated with vomiting, bilious stools, and in some instances with acute jaundice. The poison of the Daboia Russelli, of India, is peculiar in inducing phenomena which closely resemble those caused by a lethal dose of opium and at least spare the patient the terrible suffering to which the bite of the cobra, rattle-snake, and other venomous serpents give rise.

The chief post-mortem appearances are the destruction of the coagulability of the blood (except in cases of cobra bite, where the change appears to be anticipated by the swift termination of life), and sanguineous leakage into the cellular interspaces and serous cavities of the body.

The virus of the serpent may be swallowed with impunity, or applied to any unbroken surface without risk of absorption.

Treatment.—It is probable that no local treatment, however speedy, will altogether forestall absorption; but as it may be possible to intercept the ingress of some portion of the virus into the circulation, it is advisable to place a tight ligature above the seat of injury (if in a limb), to suck the punctures, and if the means be accessible, to apply a solution of caustic potash (liq. potassæ, 3 parts in 10 parts of water), to the wound. Dr. Lacerda has found good results from the injection of a one per cent. solution of permanganate of potash into the wound and adjacent tissues. Excision of the injured part may be practised where other measures are not available.

Constitutionally the symptoms may be attacked by a free use of stimulants and by galvanism. The injection of ammonia into the veins is now disapproved by most authorities. Arsenic in large doses (2 drachms of liq. arsenicalis every half hour for four successive hours) has been recommended; but there is a possibility that the mineral might, in some cases, be more dangerous than the animal poison. The internal administration of liquor potassæ may also be essayed.

HYDROPHOBIA.

Hydrophobia (*syn.* rabies, lyssa), is a disease originating in the canidæ and transferable to man by the inoculation of a specific poison, of which the usual vehicle is the saliva of a rabid animal. The virus is nearly always transmitted by means of the bite of an infected dog; but wounds inflicted by the teeth, and even the claws, of a rabid cat have been known to produce the disease; and in one recent case hydrophobia was contracted from the human subject by a physician during the autopsy of a patient who had died of the complaint.

There is every reason to believe that the contact of the poison with an unbroken mucous or cutaneous surface is innocuous, and that the potentiality of the virus disappears with the onset of ordinary decomposition.

The bite of a rabid dog fails to convey the disease in about one half of the cases, and would probably be inefficient in a far larger proportion were timely and suitable prophylactic measures always employed. The risk of infection is principally governed by the position of the injury, bites upon exposed parts of the body being more frequently succeeded by hydrophobia (face, 90 per cent.; hands, 53 per cent.) than where the teeth penetrate clothing before reaching the flesh (24 per cent.). The predominant gravity of face wounds is due partly to the greater rapidity of absorption in that region, partly to the inaccessibility of the part for the auto-prophylactic measure of suction.

Incubation.—The extremes that have been assigned to the period of incubation are two days and twenty years; but the limits may be greatly contracted in practice. Amongst the more carefully recorded cases of recent years, it has been found that the range lies between eleven days and twenty-six months, that in 75 per cent. the term falls within two months, and that in only 6 per cent. does it exceed a year. The length of incubation appears to be less in young subjects than in adults.

The phenomena observed during the incubative period are all inconstant, and none are pathognomonic. The most important may be grouped as follows: (1) Various morbid changes, inflammatory or neurotic, in the wound or cicatrix; (2) irritation of the lymphatic glands in connection with the wound; (3) the appearance of small papules or tubercles beneath the tongue, between the third and ninth days after the bite; (4) neuralgic disturbance in the neighbourhood of the wound; (5) remote nervous manifestations, as sneezing, irritability of the generative organs, etc.

Symptoms of the declared disease.—The course of the disease is generally divided, for descriptive purposes, into three stages, which, however, merge insensibly one into the other, and vary greatly in their relative importance.

1. The first, or *melancholic stage*, occasionally escapes observation altogether, and when present may vary in duration from a few hours to a week. It is marked by intense anxiety and depression, sometimes associated with irritability of temper and change of disposition, and there may also be concurrent depravation of the digestive functions.

2. The *period of excitement* is characterised by clonic convulsive paroxysms, by mental aberrations, and by impairment of the organic functions.

(*a*) The convulsive paroxysms, the first of which usually ushers in the stage, involve chiefly the muscles of respiration and deglutition, but are liable to become general. They are excited most readily by attempts to drink, and so give rise to that terror of fluids from which the malady takes its name. As the stage progresses the reflex excitability becomes so far exaggerated that any impression upon the peripheral nervous system (a touch, a noise, a flash of light) may be sufficient to determine an attack. The suffering of the patient is great, but its intensity is usually blunted by the narcotics administered in the course of treatment.

(*b*) The mental disorder, which is very characteristic of the disease, commonly assumes a type resembling that of delirium tremens, associated with spectral illusions, or may simulate certain forms of hysteria, and in either case is liable to culminate at intervals in crises of maniacal excitement. The consciousness and power of self-control, however, are seldom wholly lost, and intermissions of comparative lucidity are by no means rare.

(*c*) Impairment of the organic and particularly of the digestive functions is always noticeable in some degree. Thirst, vomiting, and constipation are frequently present, and dysuria, albuminuria, and glycosuria have been observed in different cases. The temperature may be either normal or more or less elevated, sometimes reaching even 105° or 107°.

Death may occur in this stage from spasm of the respiratory muscles or of the heart or arteries. Should no fatal complications arise, the disease passes into the final period at the end of twenty-four or forty-eight hours.

3. The *stage of paralysis and exhaustion* supervenes upon the last by almost imperceptible gradations. The violence of the paroxysms diminishes, and the muscular system becomes more and more prostrate until the patient lies motionless and helpless awaiting the arrival of the end. Despite the extreme

exhaustion, the intellectual consciousness often becomes fully restored during the last hours of life.

Diagnosis.—There is no doubt that many nervous complaints of a wholly different nature have been mistaken for hydrophobia.

Amongst several morbid conditions that even a careful observer might for a time regard as answering to the description of a malady, of which no one can be expected to own a large clinical experience, the two following may be selected as those most demanding notice: tetanus following the bite of a dog or cat; and "false hydrophobia," occurring in hysterical and highly imaginative subjects.

In tetanus (*q.v.*) as compared with lyssa: 1. The incubation is short, the symptoms in nearly all cases appearing within two weeks, a term almost invariably free from manifestations of impending hydrophobia. 2. The spasm remits, but is never intermittent, and tends to implicate the muscles of mastication rather than those of respiration and deglutition. 3. The excitability, restlessness, anxiety, delirium, and rabid impulses of hydrophobia are wanting. 4. The aversion to fluids as well as the evidences of digestive disorder are rarely present.

The "false hydrophobia" of a diseased imagination, like the feigned hydrophobia of the malinger, is nearly always fashioned in accordance with popular theory, and the resulting travesty of canine rabies would be ludicrous were it not that the misdirected expenditure of force in the former case entails great mental suffering, and may terminate in grave, even fatal exhaustion. The history of the illness, the sex of the patient (nearly always female), and a knowledge of the constitutional tendency, will aid in establishing a correct diagnosis.

Pathological anatomy.—Of the multitude of lesions hitherto revealed by post-mortem examination in cases of hydrophobia, the greater number are exceptional, and probably none are essential. The most characteristic and constant changes detected in the nerve centres by Gower, Cheadle, Coats, etc., are thromboses in the medium-sized vessels of the grey matter, aggregations of cells (leucocytes?) within the perivascular sheaths, and small disseminated areas of cell infiltrations in the substance of the nerve lesion.

These morbid features are most strongly marked in the region of the hypoglossal, pneumogastric, and glossopharyngeal nuclei. Coats has discovered also similar cell accumulations in the perivascular sheaths of the cerebral cortex, and Cheadle has observed in the same region scattered extravasations of blood associated with rod-like bodies having the appearance of bacteria. Various other changes of parts have been observed in individual cases, and hyperæmic or inflammatory lesions of the bronchial and digestive mucous membranes, and of the parenchyma of the kidneys, have also been seen with some frequency, but have not been shown to possess any special pathological significance.

The search for a specific micrococcus in the blood and tissues in the human subject has not yet been rewarded by uniformity of success; but Gibier has recently announced the appearance of a microorganism as a constant result of the inoculation of pigeons and fowls with the virus of rabies.

Whatever be the nature of the virus, it would appear that it undergoes a slow process of maturation at the point of inoculation, the resulting products entering the circulation particle by particle, until the accumulation is sufficient to vanquish the resistance of the tissues to the morbid influence, which then expends its chief energy upon the medulla oblongata and cerebral cortex.

Prophylaxis.—The various measures of prevention may be grouped under three headings: 1. Those which tend to diminish the frequency of injury inflicted by rabid dogs; a frequency which has manifested an alarming increase in this country during the past year. 2. Those which afford a prospect of rendering dogs incapable of developing rabies in its virulent form. 3. Those which oppose the development of hydrophobia after inoculation has presumably occurred.

1. In addition to the sequestration of stray dogs, the only trustworthy means of limiting the dangers of the spread of rabies is to popularise the knowledge of the true symptoms and of the measures to be taken when there is reason to suspect the existence of the disease. If the public can be induced even to learn a few simple facts of which it still appears to be profoundly ignorant: namely, that canine rabies is not limited to the dog days; that every dog which foams at the mouth is not necessarily mad, even though he may refuse to drink water under compulsion; that a dog may drink greedily and yet be hydrophobic; and that the destruction of a suspected animal is foolish as well as cruel; then much will have been gained for dog and man.

2. We are indebted to Pasteur for a remarkable series of experiments demonstrating the possibility of guarding the dog against rabies by means corresponding to that by which man is protected against small-pox. He has shown that the virus of rabies taken from a dog and passed through the tissues of a monkey undergoes great modification, and when sufficiently attenuated may be inoculated into dogs, rabbits, and guinea-pigs, without causing symptoms of the disease, yet with the effect of rendering the animals so treated insusceptible of the action of the original virus. His researches, which should be read in detail, appear conclusive, and it now only remains to demonstrate the length of the

period during which the acquired immunity can be guaranteed.

3. The prevention of the disease when inoculation has possibly or presumably taken place, as after the bite of a dog suspected or known to be rabid, may be attempted in various ways.

(α) By means employed for the removal or destruction of the virus instilled into the tissues. *Suction* of the wound may be practised where the operator is confident of the absence of any breach of surface about his own lips or mouth.

Excision of the wounded tissues is theoretically unobjectionable if performed by a skilled hand; but in practice there is great probability that the operation would be inefficiently carried out.

Actual cautery is a simple expedient, and the appliances are generally accessible; but, as in the case of excision, they are likely to be imperfectly used.

Caustics are the most easily manageable, and probably the most satisfactory of the prophylactics. As a rule the choice may be considered to lie between two agents, nitrate of silver and caustic potash; but any powerful escharotic may be employed in their place. It is probable that caustic potash would afford greater certainty of protection because of its superior penetrating powers.

The proximity of any large vessels or nerves to the seat of operation will, of course, lead the surgeon to exercise great caution in the employment of either the knife or escharotic agents.

(β) *By inoculation with an attenuated virus.*—Pasteur has recently essayed this expedient upon the human subject in many cases. Unfortunately the results of his experiments have been invested with exaggerated importance, since they have as yet proved little, except the well-known fact that a person bitten by a rabid dog may escape the development of hydrophobia; but we still look forward for wider and more decisive testimony from the same distinguished observer.

In conclusion, it may still be impressed upon the surgeon that in no case of dog-bite should the use of caustic be neglected, even though preventive inoculation be carried out; for the prophylactic value of escharotics is beyond question, and it must be remembered that their use may avert other contingencies besides that of hydrophobia. Should the wound be healed before the patient presents himself to the surgeon, the whole cicatrix should be excised if the history point to a danger of the disease.

Curative treatment.—It is to be feared that our sole advance towards a remedy for hydrophobia is a conviction of the inefficacy of everything that has hitherto been tried; yet even this negative progress is not to be despised, since it drives us yearly farther afield in search of new plans of treatment. The enumeration of all the means that have been weighed and found wanting within the present century would interest only the curious; but we may allude to a few which are shown to be of service for alleviation if not for cure.

Opium and morphia, chloroform and chloral hydrate have all been useful in assuaging the violence of the paroxysms, and of rendering the patient to some extent insensible to his suffering, but little more than this can be expected from them. The use of chloral enemata has been followed by recovery in a case of somewhat doubtful nature, in which the symptoms resembled those of hydrophobia; and both aconite and Indian hemp have enjoyed a similar reputation.

Two other drugs, curare and pilocarpine, for the present stand upon a better footing. Between 1876 and 1879 three cures were attributed to the administration of curare, but since Dr. Offenberg's successful case in the latter year, nothing has been recorded but failure. For further experiment the drug may be administered in doses commencing at a quarter of a grain and gradually increased in amount and frequency, according to the effects produced. Pilocarpine, originally suggested by Dr. Neale, has lately been administered, with favourable sequence, by Dr. Denis Dumont, in doses of one centigramme by hypodermic injection, but in a more recent case the same treatment proved unsuccessful. Lastly, on theoretical grounds, the inhalation of nitrite of amyl is worthy of trial, as an alleviative.

As an accessory measure, the destruction of the original wound or the excision of its cicatrix deserves consideration. Laryngotomy may be of service to remove the danger of spasm of the glottis; and I venture to suggest the application of cocaine to the fauces and pharynx with a view to diminish the reflex excitability of the parts. The value of inoculation with an attenuated virus after the development of the early symptoms is still problematical; but this measure, and the application to hydrophobia of a recent proposal to exterminate the bacillus of tubercle in the system by the inoculation of a more powerful but less malignant micro-organism, may be referred to as possibilities in the future treatment of the disease.

Glanders.—Glanders is a disease originating in the equine race, but transferable to other animals by inoculation. In the horse its most striking features commonly tend in one of two directions: towards the production of nasal ulcers, or towards a widely-diffused and peculiar inflammation of the lymphatic vessels and glands; and veterinary surgeons have drawn a clinical distinction between the two forms of the complaint, naming the first "glanders," the second "farcy." There is, however, no pathological ground for such a subdivision.

Etiology. — The disease in man is almost invariably traceable to direct contagion, and hence is almost confined to persons who are brought into frequent association with horses. The specific element of infection is probably a bacillus, first discovered by Christat and Kiener in 1868, and again about three years ago by MM. Bouchard, Capitan, and Charrin.

Symptoms.—The disease, which appears after an incubation averaging three to five days, but occasionally prolonged to two weeks, may manifest itself in an acute or chronic form.

Acute glanders begins with severe but not characteristic febrile symptoms, and with local phenomena at the seat of inoculation, which differ in no important respects from those of poisoned wounds in general. At the end of a few days the *specific varioloid eruption* appears, commencing with a crop of small red puncta, which become papular and then pustular, and involve not only the whole integument, but the respiratory and digestive mucous membrane, and in all cases tend to the formation of unhealthy ulcers. The *nasal lesion,* which is present in about fifty per cent. of the cases in the human subject, is a result of the invasion of the nares by the eruption, and shows itself by foul purulent discharge from the nostrils, with more or less inflammation of the skin of the face, and enlargement of the submaxillary lymphatic glands. *Multiple abscesses* in the subcutaneous connective tissue and muscles are common features, and, like the pustules, usually develop into virulent ulcers when opened. *Articular abscesses* tend to occur at a later period, and are probably pyæmic in origin.

The implication of the lungs may be manifested by signs of low pneumonia, and that of the intestinal canal by vomiting and diarrhœa.

Chronic glanders differs from the last in the slowness of the evolution of its local and constitutional phenomena, and may drag on a tedious course through months and years, or may suddenly pass into the acute form.

The *prognosis* is extremely unfavourable. Acute glanders is usually fatal within two weeks, and a complete recovery from chronic glanders is very exceptional.

The *treatment* of both affections is almost entirely symptomatic. Abscesses should be opened as they appear, and the resulting sores dressed with strong antiseptics; the nose and throat should be syringed with lotions of permanganate of potash or creasote; and pulmonary and intestinal complications must be attended to as they arise. The strength should be maintained throughout by all the resources at our disposal.

Equinia mitis is a disease allied to glanders in its transference from the horse to man, but wholly distinct in other respects. It is a local pustular eruption of the hands contracted by contagion from the equine disease of the heels known as "grease." It subsides readily under local treatment.

Malignant pustule (*syn.* **anthrax, charbon, splenic fever,** etc.) is a contagious and infectious disease transferred to man from the lower animals by means of a specific micro-organism, the *bacillus anthracis.*

Charbon, as an affection of the lower animals, is most widely diffused amongst the herbivora, and its ravages are confined to a few localities in Siberia, Hungary, the regions of the lower Danube, Holland, France, and elsewhere. The virus may be conveyed by direct contagion *in loco*, or by insects (flies, mosquitos, etc.) which have settled upon diseased animals; or it may travel to remote parts with hides and wool exported for industrial purposes. It may enter the system by inoculation through a wound or abrasion, or perhaps by absorption through the pulmonic membrane. It is destroyed by putrefaction, by the action of the gastric juice, and by a temperature below boiling point. In this country the disease has been almost limited to sorters of foreign wools.

The *local signs* of infection commence at the point of inoculation with a red punctum, which becomes papular, then vesicular; while the surrounding tissues become the seat of a gangrenous inflammation, and the lymphatic system is implicated by absorption. A characteristic ring-like eruption of secondary vesicles sometimes develops around the initial lesion about the third day.

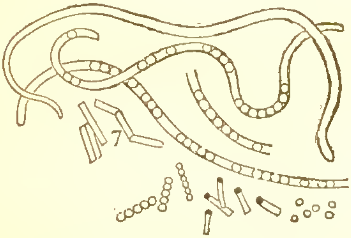

Fig. 29.—Bacillus Anthracis in different stages of development. (After Koch.)

The affection may remain localised, following the course of an ordinary gangrenous inflammation; or specific constitutional symptoms of a typhous character, with more or less cyanosis, may appear, in association with the multiplication of the parasite in the blood and tissues. Should the seat of inoculation be in the alimentary canal or lungs, the cutaneous manifestations are absent, and the constitutional symptoms are attended with indications of the visceral lesion.

The *diagnosis* in doubtful cases may be established by examination of the contents of the vesicle for the micro-organism. The *bacillus anthracis* is a rod-shaped body of $\frac{1}{2000}$th to $\frac{1}{1250}$th of an inch in length, multiplying by spores, or, under cultivation, by fission. The spores resist heat and most reagents, but may be destroyed by a one per cent. solution of perchloride of mercury, a five per cent. solution of permanganate of potash, or by solutions of chlorine, bromine, or iodine. It is found in all parts of the body, but especially in the capillaries, where the accumulation may be sufficient to induce a local arrest of circulation.

Treatment.—Excision of the pustule and indurated tissues in its neighbourhood, followed by the frequent application of disinfectant washes of permanganate of potash (2 to 5 per cent.) or chlorine lotion. The strength of the patient must be maintained with stimulants and nutrients.

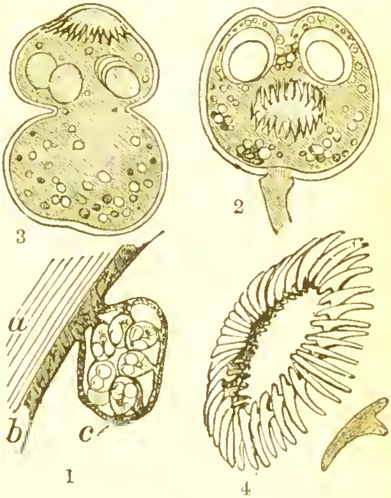

Fig. 30.

1, Section of wall of echinococcus cyst. *a*, laminated wall; *b*, germinal membrane; *c*, daughter cyst with scolices. 2, Isolated scolex with pedicle; cephalic end invaginated (× 100). 3. Scolex with head protruded. 4. Circlet of hooks (× 350).

Echinococcus.—The echinococcus is the scolex of a tapeworm infesting the dog and wolf, and completes its development in the bodies of man and certain other animals. The parasite is common in Iceland but rare in this country.

The ova of the tapeworm, upon expulsion from the intestine of the dog, may fall upon vegetation used as food by man, and may so gain admission into the alimentary canal of the human subject. As soon as it enters the stomach its capsule is dissolved by the gastric juice and the liberated embryos pierce the blood-vessels and connective tissue interspaces by means of an apparatus of hooks with which they are provided, and so become distributed over various parts of the economy of their new host. The liver, as the first recipient of the intestinal blood, is the most frequent seat of arrest; but the lungs, muscles, subcutaneous connective tissue, kidneys, pelvis, nerve centres, and many other parts of the body may provide a habitation for the parasite.

The embryo, on finding a resting place, casts off its now useless hooks, and becoming invested with a capsule formed at the expense of the neighbouring tissues, thenceforth develops into a hydatid cyst, devoting existence to the work of propagation. The endogenous or typical hydatid appears as a laminated, elastic, semitransparent vesicle, filled with transparent non-albuminous fluid, and containing a number of daughter cysts, which, in turn, may enclose a third and even a fourth generation; while each cyst presents, attached to its inner surface or free in its cavity, a multitude of scolices having the characters indicated in Fig. 30.

In certain cases proliferation of the hydatid may take place exogenously by the development of secondary cysts from the outer surface of the parent, or the tumour may be constituted by a host of vesicles embedded in a connective tissue interspace.

The *symptoms* are ordinarily limited to those attributable to pressure upon adjacent parts, but complications may arise from suppuration or rupture of the cyst.

Treatment.—The cyst should be removed entire, if the part be accessible for the purpose; in other cases, as in the liver, the choice lies between the injection of irritant fluids (iodine, etc.), and an operation by means of which the cyst wall is united to the edges of a parallel incision, the contents then being evacuated by incision.

Delhi boil (*syn.* **myosis, Aleppo boil**) is an ulcerative affection of uncertain nature, endemic in various localities in India.

The disease first shows itself upon some exposed portion of the body in the form of a red spot, slowly enlarging into a flat tubercle, which, at the end of a few weeks, breaks down into ulceration. The sore then spreads in all directions, destroying everything in its path, and closely resembling lupus both in progress and results.

The pathology is very obscure. Dr. A. Smith attributes the disease to the action of a parasite residing in the tank water, and which probably enters the body through the sudoriparous pores; and Dr. V. Carter has discovered the mycelium and spores of a fungus in the dilated vessels of the affected part, but the causative relation of the organism to the disease has yet to be proved. Drs. Lewis and Cunningham, on the other hand, believe it to be a form of lupus.

Treatment.—Destruction of the sore with caustics, preceded or not by scraping, and followed by the use of antiseptic and stimulant applications.

The **trichina spiralis** is a nematode worm which may inhabit the muscular system of the mammalia, and especially of the pig, and is transferred to man by the consumption of imperfectly cooked trichinasised meat.

As soon as the parasite enters the alimentary canal its active life is resumed; it propagates with extraordinary rapidity, and within a few days liberates a swarm of embryos, which, piercing the walls of the intestine, travel by way of the intercellular spaces and lymphatics and blood-vessels till they reach the muscles, where they become encysted.

The *symptoms* due to the invasion of the parasite are: 1 Intestinal irritation excited by the passage of the embryos through the wall of the gut. 2. Muscular irritation associated with the process of colonisation amidst the sarcous elements, and manifested by pain and loss of power in the parts attacked. 3. A peculiar œdema appearing about the seventh day, and tending to become general. 4. Constitutional disturbance in the form of pyrexia and prostration, which may merge into a typhous condition in unfavourable cases.

The process of encystment is accomplished in the course of six or seven weeks, at the end of which time

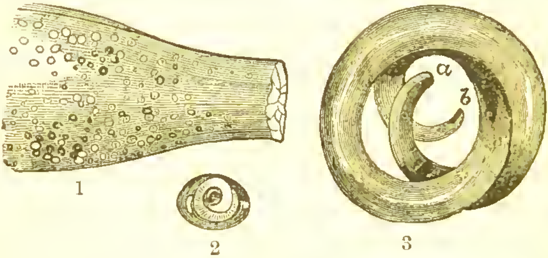

Fig. 31.—Trichina Spiralis.

1. Portion of muscle with embedded trichinæ. 2. Cyst in process of calcification. 3. Trichina (× 200); *a*, caudal end; *b*, cephalic end.

all active disturbance ceases, and the convalescence of the patient begins.

The trichina in its encysted form appears as a worm about half a line in length, coiled up inside a minute oval capsule (long diam. $\frac{1}{75}$th of an inch), lying within the sarcolemma amidst the primitive fibres.

Treatment is alleviative and supporting.

The **filaria medinensis** (syn. **Guinea worm,** or **dracunculus**) is a nematode worm peculiar to certain tropical and subtropical countries (India, Africa, etc.), and in its embryonic form appears to reside in the mud of tanks and ponds. It gains admission to the human body by way of the sudoriparous ducts, or hair follicles of exposed parts, and especially of the foot, subsequently developing in its new host to a length of three to six feet, and causing severe inflammation of the tissues implicated, until suppuration occurs and the opening of the abscess shows the head of the parasite.

The *treatment* recommended is to extract the worm whole by winding the exposed cephalic extremity around a piece of wood, and turning the latter a little day by day until the tail emerges. Should the parasite be broken in the process, the decomposition of the far-reaching coils induces acute and deep-seated inflammation of the affected member, and amputation may be demanded to save life.

The **filaria sanguinis** is a nematode worm found in most parts of the world, but chiefly infesting tropical and subtropical climates. It probably exists in at least two distinct forms, of which one represents the embryonic, the other the mature stage of existence. The former, of microscopic dimensions ($\frac{1}{200}$th to $\frac{1}{70}$th of an inch in length), may be found in the human subject in the blood, lymph, urine, and tears, and their elimination by the kidneys may give rise to chyluria and hæmaturia. The adult worm has been discovered outside the vessels, where it may set up lymphatic abscesses, a kind of hydrocele, and the various manifestations of elephantiasis Arabum. The parasites are believed to attain sexual maturity in the alimentary canal of the mosquito (which swallows the embryos in the course of its attacks upon infected animals), and when set free from the body of the insect, to gain admission, by means of articles of food, into the human economy, where they discharge the new generation of embryos into the blood and lymphatics.

The **chigoe** or **jigger** (*pulex penetrans*) is a parasite of the flea tribe, belonging to the West Indies and tropical and subtropical parts of America. It infests sandy places; and the impregnated female, in search of a refuge wherein to accomplish the term of her gestation, attacks the feet of wayfarers, boring her way through the integuments to effect a lodgment in the subcutaneous tissues. Once established, the intruder begins to expand, till, from about half the size of the common flea, she attains the dimensions of a pea. The surrounding tissues become inflamed, suppuration sets in, and should the insect be accidentally crushed, and the embryo be diffused into the connective tissue spaces, tedious ulceration or even gangrene of the toes may follow.

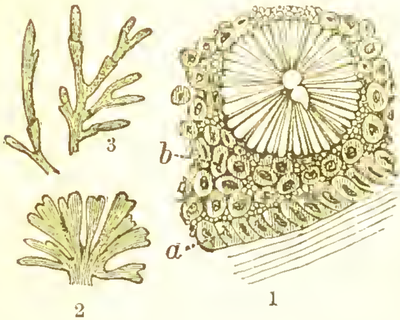

Fig. 32.

1. Section of Actinomyces granule, embedded in the mucous membrane of a bronchiole. *a*, epithelium of bronchiole; *b*, lymphoid cells. 2. Detached radial elements of a granule. 3. Similar elements from a case of bovine actinomykosis. (From Real Encyclop. der. Heilk.)

The *treatment* is to lay bare the chigoe and endeavour to extract it entire. Should the insect have been destroyed *in situ*, the resulting ulceration and sinuses must be treated on general principles.

Madura foot, or **mycetoma,** is a chronic inflammatory disease of the foot terminating in extensive undermining of the tissues by sinuses and cavities. In certain districts blackish masses of fungoid capsules and filaments (*chionyphe Carteri*) are found in the discharges; and with these, or existing alone in other cases, are yellowish particles, which appear to be simply of fatty composition. It is uncertain whether the parasite is a cause or a complication of the disease.

The affection is usually very chronic, and rarely repays attempts at conservative treatment.

Actinomykosis is a parasitic disease originating in cattle, and transferable to man probably by way of the alimentary canal. In cattle the complaint commonly shows itself in a kind of tumour formation in the upper jaw and parts about the mouth; in man by an inflammatory proliferation about the jaws and neck, which runs quickly into suppuration, and tends to burrow in all directions and through all tissues, till every part of the body may be implicated. The condition may present some resemblance to tubercular disease, but the diagnosis can be established by the detection of the parasite in the discharges. The course is always lingering, and ends fatally in about 60 per cent. of the cases.

The *Actinomyces* are vegetable parasites visible to the naked eye as yellowish particles as large as fine grains of sand, and under the microscope appearing as round, oval, or irregular bodies composed of a number of branched or club-shaped rods (conidia) radiating on all sides from a common centre or conidiophore. They are invested on all sides by granulation tissue formed at the expense of the irritated tissues.

The *treatment* in the early stages is to lay open all abscesses and sinuses, to scrape away the granulation tissue so far as it may be safely reached, and to syringe the parts repeatedly with lotions of permanganate of potash or other antiseptic. When the disease has extended to the viscera, the only available measures are those of a symptomatic and sustaining nature.

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